REPORT

ON

INSECT AND FUNGUS PESTS.

PREFACE.

THE Fruit-growing industry of this Colony being of considerable importance, and being likely to increase as the area of land under crop extends, it is advisable that fruit growers should be placed in possession of all available information to enable them to grapple with the numerous insect and fungus pests that have hitherto caused such damage in our orchards.

The following Report, therefore, of Mr. Henry Tryon, recently published as a Parliamentary Paper with the title, "Inquiry into Diseases affecting the Fruit-trees and other Economic Plants in the Toowoomba District," being considered too valuable to be simply confined to the shelves of a parliamentary library, is issued in the present form by this Department, with the permission of the Honourable the Secretary for Public Instruction.

M. HUME BLACK,
Secretary for Public Lands.

Department of Agriculture,
Brisbane, October, 1889.

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REPORT

ON

INSECT AND FUNGUS PESTS.

TO THE HONOURABLE THE SECRETARY FOR PUBLIC INSTRUCTION.

Queensland Museum,
Brisbane, 20th July, 1889.

SIR,—I have the honour to forward the accompanying "Inquiry into Diseases affecting the Fruit-trees and other Cultivated Economic Plants in the Toowoomba District," undertaken in pursuance of verbal instructions received from the Honourable the Colonial Treasurer on the 25th January, 1886.

For the immediate purpose of this inquiry I proceeded to the Toowoomba district on the day on which my instructions were received, and between this date and the 9th February inspected the following gardens and cultivations thereof—viz., those occupied by—

Mr. Bushnell, Isaac street.
Mr. Buziko, Alderley street.
Mr. W. Feljenhauer, Alderley street.
Mr. H. Gorman, Crone street.
Mr. Gregory, Drayton.
Hon. W. H. Groom, M.L.A., Ruthven street.
Mr. Hanley, Paradise, Drayton.
Mr. C. H. Hartmann, Range Nursery.
Mr. Heissle, Hume street, Middle Ridge.
Mr. H. Hertzer, Middle Ridge.
Mr. W. Hitchcock, Mount Pleasant.
Mr. J. Holmes, Ballard's Camp, Highfields.
Mr. H. Hyer, Crone street.
Mr. W. King, Bridge street.
Mr. Lehnemann.
Hon. W. Miles, M.L.A., Raceview (gardener, Mr. Lowe).
Mr. Miller, Highfields road.
Mr. G. Noss, Main Range.
Mr. H. Roessler, Crown street Gardens, Highfields road Gardens, and Gowrie Creek Gardens.
Mr. G. Searle, Rose Hill Gardens.
Mr. J. T. Smith, Herries street.
Mr. M. Stenner, Middle Ridge.
Hon. J. Taylor, M.L.C.
Mr. C. Volker, Kline street.
Mr. A. Voss, North street.
Mr. F. Wokner, Bridge street.

This inspection was resumed on 18th February and continued during the following day, when the gardens occupied by the following gentlemen were visited :—Mr. W. Baynes, Spring Lawn (Mr. H. Hopkins, gardener), Mr. H. M. Nelson, Main Range. The occupiers of the gardens and cultivations alluded to were wherever practicable interrogated.

In addition to this, evidence was taken from Mr. Bange, Back Plains, Clifton; Mr. B. Crow, senr.; Mr. R. K. Fraser, George Street; Mr. G. W. Griffith, Mr. R. Green, Mr. A. McDowall, Mr. J. B. Robinson, West Swamp; and Mr. H. L. Pentecost.

It is evident on consideration of the time occupied by these inspections, that though many of the gardens and cultivations were visited more than once, none were thoroughly examined. It may, therefore, occur that some of the pests of vegetation have been overlooked during this inquiry.

It may be objected that undue weight is given to plant enemies whose influence is little felt by the cultivator. These, nevertheless, inflict considerable damage, although this fact may not be appreciated by those who have never harvested a crop free from the diminishment in amount or deterioration in quality which is inseparable from their presence.

Agreeable with the practice of those who in other countries have dealt with analogous subjects of inquiry, the features presented by the different pests have been treated with some minuteness of detail. It is only when thus fully characterised that their position can be defined amongst the many thousands of insects and fungi which our fauna and flora comprises. By this method of treating the subject, too, the labours of future inquirers will be lessened, for they will now have the materials for tracing the connection, if any, existing between the diseases with which they are called upon to deal with what is previously known. The records of the Privy Council inform us that when in 1788 there appeared imminent risk of introducing into the United Kingdom the Hessian Fly from America, it was discovered that there existed no description, nor was any forthcoming, by which this insect could be distinguished from the host of its innocent congeners. Until recently the characters of the Apple Bark Scale have never been fully set forth, and hence it is that a knowledge of the measures which have been adopted for its extermination can only be acquired by perusing the literature relating to at least six nominally different insects.

It will be noted that the reports of previous writers on vegetable pathology have been frequently laid under contribution. This has been done because the statements which they contain are often *à propos* and because they embody final conclusions. In quoting the titles and authors of these reports wherever occasion arises, endeavour is again made to facilitate the labours of future workers.

It may seem that more than due prominence is given to the consideration of pests which have not yet become established in the orchards of Toowoomba, nor, in one instance, even elsewhere in the colony. This course has been adopted because their presence there may at any time be expected, and insomuch as the history which has attended their visitation in other countries may be repeated also in this, it is expedient it seems that when they do come they may be promptly dealt with.

Crops after being harvested are still, as you are aware, subject to the injurious attacks of various insects, but as their consideration may be profitably dealt with in a separate inquiry, it is for the present postponed.

Considerable stress has been laid upon the conditions under which plants are grown at Toowoomba, since such conditions, as is well known, modify the extent of the injuries due to disease to which plants are subjected, even when they do not determine its very existence.

Some special consideration has been given to the natural foes of the pests of vegetation. This is because experience shows that the fact—that it is more profitable to assist nature than to thwart her in preserving that equilibrium in animal life on the maintenance of which success in agricultural operations partly depends—seems hitherto to have, here, escaped recognition.

I would especially point out that the remedies mentioned in connection with the different plant ailments are not such the practical utility of which has always come under my observation, but are those which have been recommended for contending with either identical pests, or those of analogous habits, in other countries and often as the outcome of elaborate experimentation.

In conclusion, I have to express thanks to the Museum authorities for having given me permission to visit Toowoomba, and also for allowing me to conduct a large series of experiments undertaken for the purpose of investigating the life-history of the fruit-fly, and for establishing its precise relation to quite a number of fruits which it was known to attack; also to the Colonial Botanist, whose assistance in forwarding specimens of various Blights to England for purposes of nomenclature has been very material. The Hon. W. Macleay, Dr. T. L. Bancroft, Mr. L. A. Bernays, Mr. H. Roessler, and Mr. G. Searle, are others to whom the report is indebted.

With the above exceptions, my duties at the Museum, and those imposed upon me by my connection with the Intercolonial Rabbit Commission of New South Wales and Stock Disease Board of this colony, have so fully taken up the time set apart for official work that the preparation of this report has largely occupied my leisure, which has had, too, to meet the claims of other urgent business on its expenditure. It has happened, therefore, that the prosecution of this inquiry has been unduly protracted; at times it has even been practically suspended.

I have, &c.,

HENRY TRYON.

INTRODUCTION.

PREVIOUS INQUIRIES.

With the exception of inquiries conducted by private individuals, efforts to investigate the diseases of plants cultivated in the colony seem to have been limited to what has been accomplished by the Board appointed in February, 1875, to "Inquire into the Causes of Diseases affecting Live Stock and Plants." The funds at the disposal

of this Board during 1875-7 amounted to £2,500. It brought up four Reports, the first relating to its work up to 30th June, 1876, the second dealing with the interval between this date and 30th June, 1877, the third in 1878, and the fourth dated 26th March, 1879.

Restricting our attention to its labours in the domain of Plant Disease, we find that these may be fully summarised as follows:—

General recommendations.—The prevention of new diseases, by giving effect to the following suggestion:—"In reference to the introduction of diseases and insects injurious to vegetation through the importation of infected plants, the Board is of opinion that it would be desirable to have all imported plants carefully inspected, and if found diseased, subjected to such treatment as will prevent their spread to other plants here" (*vid.* Report, 1877, p. 2).

Pip Fruits. (Apple, Pear, Quince.)—The Board failed to report even the mere existence of any disease affecting these.

Stone Fruits. (Peach, Nectarine, Apricot, Almond, Plum, &c.)—It reported the mere existence of the "grub," in some cases, in the peaches of East and West Moreton and the Darling Downs, and of "disease" in those of Rockhampton.

Citraceous Plants. (Orange, Lemon, &c.)—It reported the mere existence of "parasites" affecting the Orange in the East and West Moreton, and Darling Downs districts, and made the following statements concerning "a disease of the bark," "scale insects," and a special leaf fungus, as occurring in orange trees.

(1) "The *Orange* family suffer occasionally from a disease of the bark near the root; a gummy secretion exudes and the tree dies. This happens occasionally after a slight bruise from a gardener's tool. The disease has not been carefully examined." (*Report*, 1876, p. 16.) (2) "So long as plants of the orange family keep free from *scale* insects, they thrive in any situation." (*Ib.* p. 16.) (3) "The common lemon generally shows a *fungus* growth in the structure of the leaf, producing a yellow rough scab. This fungus *probably* pervades the structure of the plant, and its examination *might* yield materials worth knowing (*sic*)." (*Ib.* p. 16.)

The Vine.—The Board, in addition to circulating a pamphlet on Phylloxera, reported as follows:—

"The varieties (of grapes) principally grown, and which have proved themselves most successful, are the Isabella, Black Hambro', B. Prince, Sweet Water, Royal Muscadine, Hermitage, Muscat B. Cluster, Wantage, Scuppernong, and others. Oïdium has appeared in all districts but the Mitchell, which, up to the present time, has been free from all disease. The only varieties which have not been attacked by oïdium are the Isabella and the Scuppernong, and in some districts B. Hambro'. The use of sulphur has been the only means employed; and although it has not had the effect of eradicating the disease, it has succeeded in keeping it under very considerably. It is not subject to other disease, or parasites, when proper attention is paid to it" (*vid.* Report, 1876, p. 18).

Other Fruits.—The Board failed to report the existence of disease, affecting any of them.

Vegetables.—The Board discovered the existence of the *aphis* on the *cabbage* in every district to which its inquiries were directed. It repeats several suggestions which it has received relating to the destruction of this pest, and gives its own conclusions as follows:—"The leaves first observed affected with *aphis*, or the entire plant, should be removed and burnt. After the plants suffer much all

remedies are ineffectual" (*vid.* Report, 1876, p. 15). It states that "*pumpkins* are attacked by a small red beetle" and that "Gidea ashes have the effect (of driving this pest away) when sprinkled on the leaves when wet" (*Vid. l.* c). Also concerning the leaf fungus of this plant and its cure :—"To destroy the fungus which produces the white mould on the leaves of the *cucumber* and *pumpkin*, watering the surface of the leaves with two ounces of salt in a gallon of water, or a weak ley of ashes, or dusting over with sulphur, as in the vine disease, will be curative."

Cereals: Wheat.—In its first report the Board merely announces the fact that "wheat *is said* to become rusted in alluvial flats in the Moreton and Darling Downs districts—white wheat suffering most," and that with the exception of "rust and smut," which have attacked the wheat in these districts, it is free from disease. (*Vid.* Report, 1876, p. 14.) In its second report the Board confirms the results arrived at by Dr. Schomburgh, in Adelaide, as to the identity of the rust fungus of wheat grown in Australia with that of the wheat of Europe, and therefore the propriety of using the same method of treatment in both places. In report No. 4 the importation of seed wheat from Mexico and Southern Europe is announced. *Maize.*—The Board reports that this cereal "does not suffer from disease," but that "Mr. Ratcliffe, of Oxley, mentioned sugar-cane rust attacking maize grown on old cane lands" (*vid.* Report, 1876, p. 14). This ends what the Board reported concerning the cultivated plants embraced in our inquiry.*

* The remaining work of the Board concerning the diseases of plants is the following:—

Pasturage.—In the prosecution of an inquiry into an alleged deterioration in the quality of the grasses of our pastures, it was led to undertake a series of experiments to test the relative value of indigenous grasses as food for stock, by comparing their behaviour under cultivation with the appearances which they presented under their natural circumstances of growth. The deterioration was found to be due to overstocking and consumption by marsupials. It also sought to improve the pastures by the introduction of fresh fodder plants.

Sugar Cane.—The Board reports an epidemic of sugar-cane rust occurring throughout the colony in June, 1875, and gives a report, by Mr. R. Muir, detailing the results of his visit to the rust-infested districts of the colony (*vid.* Report, 1876, pp. 23-28). The origin of this rust disease is reported on by Mr. R. Muir, by Mr. W. Hill, Mr. K. T. Staiger, and Dr. J. Bancroft. The first of these finds that it is caused by special meteorological events, and that the susceptibility of the sugar-cane arises from its being grown in soil which is either too highly manured or naturally too richly endowed with nutrient elements. Mr. Hill finds that it arises from the same cause, but that the susceptibility is due to the resistance to acclimatisation which plants introduced from a tropical to a temperate climate offer, and their consequent enfeebled growth (*vid.* Report, 1876, p. 28). Mr. Staiger finds that the disease is in its later stages decidedly a fungoid one, that it is caused by climatic events, but that the susceptibility of the sugar-cane is due to the previous removal from the soil by it of elements required for its proper growth, and not by the soil being unduly rich (*vid.* Report, pp. 28-31). Dr. Bancroft makes two special reports, illustrated by plates, both of which relate to the fungoid nature of the disease. In the first he describes the microscopic appearances presented (*vid.* Report, 1876, pp. 10-2023, Pls. 1 and 2); in the other he traces the fungus, which he notices in the first report, to the attacks on the sugar-cane of a small acarus. He also bases a course of treatment for the "rust" on his discoveries, and narrates experiments conducted by himself in support of his recommendations (*vid.* Report, 1877, Appendix K., p. 12-13, Pl. 1). The Board also alludes to the introduction of the *Pou Blanc* on sugar-cane from Singapore; and Dr. Bancroft specially reports on this, and illustrates its appearance and mode of occurrence on the plant (*vid.*

Investigations conducted by private individuals are confined to those which have been prosecuted by Dr. J. Bancroft. The following is a brief summary of these :—*Citraceous plants*—He notices in June, 1879,* the occurrence of several scale insects on citraceous plants, under the following designations :—The "*Pinna scale*" (either Chionaspis Citri or Mytilaspis Gloveri—H.T.), "*the large hemispherical scale*" (probably Lecanium Oleæ—H.T.), "*Limpet scale*" (probably Aspidiotus coccineus—H.T.), "*Red-cap Limpet scale*" (probably Aspidiotus ficus—H.T.), "*White powdery scale*" of bark (probably male of a Chionaspis—H.T.).

Banana Disease.—At the same time Dr. J. Bancroft notices his discovery of a diseased condition not only affecting the banana, but also several important garden plants. On the roots of these he finds numerous swollen bodies, which contain cavities in which reside nematode worms (*i.e.*, animals allied to the paste eels—*Anguillula*) or are occupied by flask-shaped bodies, filled with young worms of the same class, and ova in which the embryonic nematodes are plainly visible. This disease, which he fully describes and figures, he names the *Flask Worm Disease*‡ (*vid. Op. cit.*, pp. 9-11 and plate).

Wheat.—Dr. Bancroft has also experimented during many years with a view to discover a rust-proof wheat, suitable for growth in the colony. The results of his investigations in this direction have been communicated to the public in a paper entitled "Experiments with Indian Wheats in Queensland."†

Maize.—His most recent investigation is designated "An inquiry into the Maize Disease of the Caboolture District."‡ In this Dr. Bancroft arrives at the conclusion that this disease is caused by the attacks on the maize of the caterpillars of a small moth, *Conogethes punctiferalis*, Guen.

The incentives to inquiry, on the part of private individuals, have been afforded, (1.) By the Government of the colony offering, in 1878, a reward for the discovery of an effectual remedy for rust in wheat; and by its reprinting, in 1886, by permission of the Government of New Zealand, the "Interim Report" of Prof. T. Kirk, F.L.S., on the "Fruit Blights and Diseases of Fruit Trees," prevalent in that colony. (2) By the action of L. A. Bernays, F.L.S., in urging the claims of economic entomology, and especially that province of it which relates to plant pests, upon the attention of students.§

Report, 1877, p. 2, Pl. II). [It does not appear that the insect depicted by Dr. Bancroft on the plate illustrating this report is the *Icerya sacchari.* In Report No. 4 Mr. D. Macpherson mentions a second "white louse" as introduced in cane from Java. In Mauritius *Pou Blanc* is applied to several sugar cane insects.—H. T.]

Banana.—The Report for 1876 contains the statement of a conclusion arrived at by Dr. J. Bancroft that the so-called rust of the banana is of fungoid origin. (*Vid. Op. cit.*, p. 31-2.)

* "Diseases of Animals and Plants," by Dr. Bancroft. A lecture delivered at the Divinity Hall, Brisbane, 16th June, 1879.

† Proc. Roy. Soc., Qd., vol. I., pp. 176-180, Brisbane, 1885.

‡ *Op. cit.*, vol. III., pp. 108-111, Brisbane, 1887.

§ *Vid.* "Economic Entomology," a paper read before the Royal Society of Queensland. (*Vid.* Proc. Roy. Soc. Qd., vol. II., p. 13.

THE SOIL OF TOOWOOMBA.

No statement concerning the mechanical or chemical constitution of the Toowoomba soil seems ever to have been published, and an analysis of "super soil," which Mr. H. Symes was instrumental in obtaining in November, 1879, the results of which are before us, throws but little light on the subject. The influence therefore of the soil of the district on the growth of or on the occurrence of diseases in cultivated plants cannot be defined with any certainty.

A chemical analysis, if conducted by the use of solvents not going deeper than those naturally acting in soils bearing vegetation —a limitation usually insisted upon by agricultural chemists now-a-days—would teach us what plant food was available for cultural purposes, whilst a mechanical one would point out to what extent the value due to the presence of this food material would be modified by physical conditions proper to the soil itself. For instance, mechanical analysis would show to what extent the food material was accessible to the roots of a growing plant which, by chemical analysis, had been found to be present in abundance, and by this means we should discover the reason why two soils containing a like amount of food material were, as judged from the quantity and quality of plants raised on them, of very different value—a fact easy to be understood by this consideration, amongst others, that the degree to which the chemical peculiarities of a soil can be exercised for the benefit of plants growing upon it is directly proportionate to its fineness, or the extent to which those parts which are soluble under the ordinary process of growth, and those which are insoluble also, are divided. The important part which the fineness of a soil exercises may be best understood on consideration of the fact that a large part of the food substance of plants which it contains exists in a fixed or absorbed condition, not being extracted even by large quantities of water; and that in order that the plant may obtain it this food substance must be operated upon by the carbonic acid which the roots exhale, and at those points of contact which these roots, for the purposes of acquiring food, make with the soil, that is at the tips of their root-hairs. It is therefore necessary, if all the root hairs are to be functionally active, or in other words, if vigorous growth is to take place, that these absorbed food substances should be as generally distributed in the soil as possible; and this distribution is directly related in its extent to the fineness of the soil, since these bodies, as has been supposed, occur as extremely fine coatings on the surface of its particles.* So, too, the simple investigation of the amount of water which a soil can absorb yields results of immense importance to the agriculturist, since its fertility is largely dependent on the moisture which at any

* Practical illustration of this last proposition may be found in what is observed at Southport, near the jetty there, at which spot a black sandy soil is exposed, below the level of high water. Fresh water continuously percolates through this soil without diminishing the extent or intensity of its colour in any way—and it may be used as a filtering medium, and yet the substance on which this colouring depends is limited to the surface of fine particles of silica—of which the bulk of the soil is composed. This fact may be discovered by heating some of this soil, when, as a result of this operation, its blackness will give rise to snowy whiteness; or by noticing the changes affected there—in Nature's laboratory—by the action of the chemical substances dissolved in sea water upon it, the denudation of this black soil by the salt water giving rise to the snowy white sand of the sea-shore. So again may this particular black soil be reconstructed from the latter,

time it contains, and its ability to support vegetation during the prevalence of drought, on its value as an absorbent of aqueous vapour. On the other hand, its power of arresting the passage of water through it, or in other words, of retaining it, may have a highly deleterious effect on vegetation. Clay in its natural state, such as exists in the subsoil at Toowoomba, is an instance of the truth of this assertion.

Returning to the subject of the chemical constitution of the soil, the importance of the ascertainment of this is obvious when it is borne in mind that all plants derive the greater part of the material of which they are built up from it. The composition of particular plants being, generally speaking, definite within certain limits, by knowing what the soil contained we should have some indication of what plants it was naturally best suited to support, or what substance was required by it in order to render it fertile in respect of a particular crop for the growth of which it was not naturally adapted.

As far as we could ascertain, no one, at the time of our visit, had any certain knowledge, and very few indeed even entertained an opinion as to the physical quality of the soil on which they depended for their livelihood. And had information on this subject been accessible to us we should have been able to explain the ill success attending the cultivation of certain economic plants, and have been able to point out that that state of things would be likely to prevail as long as the art of ameliorating the physical condition of the soil was either not understood or, if known, not put into practice. Suffice to remark, as the result of our observation, that the chocolate soil of Toowoomba is rich in iron and alumina (clay), and in insoluble silica, but generally poor in lime (except locally, where the soil has evidently been largely derived from basaltic rock unusually full of zeolites rich in this element), also that it has great absorbent capacity for water. This last—the moisture co-efficient of the soil—would be rendered high owing to the very large amount of ferric hydrate present, and to the fact of its being generally and finely diffused. It is for this reason that the Toowoomba soils are not so banefully affected by drought as are those of other districts. We are certainly of opinion that lime is one of the desiderata, and that good results would follow its application to the land. The productiveness of a soil for the time being is intimately connected with the presence of lime, and this mineral as a soil constituent should never be allowed to fall below a certain minimum, different for different varieties of land. Lime is not only the medium for the conveyance of nutrient matter to the tissues of plants, but it also serves to neutralize the action of deleterious bodies, both when these already occur within them or come into contact with them in the soil. In the plant-tissue it serves to precipitate different acid bodies. When in the soil it not only in certain cases helps immediately to ameliorate its physical condition, but it also by its presence serves to prevent sulphur and iron which have once oxidised from forming, in the unaerated subsoil, ferrous sulphate—a body poisonous to vegetable life.

STATE OF CULTIVATION.

Drainage.—A very noticeable feature in agriculture as practised at Toowoomba is the complete absence of all artificial drainage. If the question is asked—is the land drained? what system of drainage do

you adopt? or where are the drains situated? the information is elicited that the practice of drainage is wholly ignored; or you are perhaps told that, as a rule, there is no superfluous water at Toowoomba to remove by this means; thus implying that the chief function of drainage is altogether lost sight of. True, the most obvious purpose to be accomplished by drainage is the removal of the superfluous water which otherwise might lie about. Such is the drainage of streets. But to drainage agriculture looks for a good deal more, and therein lies its especial value, for it prevents the soil from becoming "sour" from retaining its coldness, whilst at the same time it increases its fertility. How, it may be asked, does it accomplish so much? First, then, with regard to its influence on what farmers call the "sourness" of the land. Soil has the power of retaining a certain amount of water, and a heavy soil like the subsoil of Toowoomba a great deal. When rain falls it sinks down to the level of the subsoil, and is thereupon retained by it, and can only be removed by drainage or by evaporation. Whilst it is present it prevents access of air to the subsoil, and therefore the oxidising action of this agent on the constituents of the latter. These bodies are then dependent, for this office, on the oxygen which the water holds in solution, the combining capacity of which is soon satisfied. Under these circumstances the organic matter has to obtain its oxygen from the reduction of oxidised bodies already present in the soil, and especially from the iron salts which accordingly become reduced. It therefore happens in a soil like that at Toowoomba, which contains so much iron, that this mineral which operates so beneficially in dry seasons by determining a high percentage of absorbed water, which is especially needful then, becomes injurious when the water is allowed to stagnate in the subsoil as it does in an undrained land. For the ferric salts become reduced to ferrous salts—*i.e.*, to bodies absolutely poisonous to vegetation, (to express in scientific language what is implied in the statement that the land becomes "sour,") and to adopt the language of Professor E. W. Hillgard, "this reduction of the ferric hydrate to ferrous salts most commonly in the subsoil manifests itself promptly by the blighting of the crop."* But drainage also, as we have stated, influences the property of soils of retaining their "coldness." Now, when the subsoil becomes saturated with water, this water in the absence of drainage can only be removed by evaporation. And thus the heat of the sun does not act beneficially by causing a genial warmth to pervade the soil uniformly throughout its whole extent, but actually cools it by becoming latent or losing the quality of sensible heat through this very evaporation; or if, and this happens when evaporation has proceeded to a certain extent, the surface may become warm and so heat the water which is in the soil immediately adjacent to it, this increase of temperature does not extend downwards, since it cannot overcome the law of convection, and for the reason also that water is such a bad conductor of heat. On the other hand, when the soil cools by nocturnal radiation of heat, this lowering of temperature extends downwards, in obedience then to the law of convection, and so the subsoil is cooled afresh. We have, then, a plant growing under these conditions:—That portion of it which is above ground is, perhaps, subjected to a burning sun, around the "collar" there are perhaps two or three inches of parched soil, whilst the roots are surrounded by a

* "The Objects and Interpretation of Soil Analysis," American Journal of Science, 3rd series, vol. xxii., 1881, p. 196.

cold as well as poisoned subsoil. As a result we have the plant dying in, as is so often objected, "a highly mysterious manner," or as we should say, struggling to exist under such circumstances, whilst the real mystery would be how it managed even to do this. Drainage also increases the fertility of the soil. Without entering into details we may state generally that a system of air passages or channels, which, after all, is the definition of drains, effects the disintegration and pulverisation of the soil—results highly desirable, again, in the case of the stiff clay soils of Toowoomba. Now, this disintegration allows water to quickly pass through the soil—in other words to irrigate it. Secondly, a far larger amount of the vapour of water and also ammonia and carbonic acid to be absorbed. And thirdly, it permits admission to the passage of air—*i.e.*, the aeration of the soil. Concisely stated these results accomplished may be thus explained :—

"Rain water always contains in solution air, carbonic acid, and ammonia. The oxygen of the air and the carbonic acid being both in a highly condensed form by being dissolved, exert very powerful affinities on the ingredients of the soil. The oxygen attacks and oxidises the iron, the carbonic acid seizing the lime and potash, and other alkaline ingredients of the soil, produces further disintegration, and renders available the locked up ingredients of this magazine of nutriment. Before these can be used by plants they must be rendered soluble, and this is only effected by the force and renewed access of rain and air. The ready passage of both of these, therefore, enables the soil to yield up its concealed nutriment. The soil thus acted upon becomes soon changed to a certain extent in its mechanical, as well as its chemical, character. The particles of soil being comminuted are rendered more absorptive of the gaseous foodof plants—carbonic acid and ammonia. The porous soil thus becomes richer in organic food ; at the same time it is made to yield its nutritive mineral riches to the plants growing upon it. The peculiar chemical action exerted by the surface of soils for fixing ammonia and other soluble ingredients in water becomes more powerfully exerted."—(*Lyon Playfair* on the "Theory of Drainage.")

Enrichment and Exhaustion of Soil.—However naturally fertile the Toowoomba soil may be, there can be no doubt that the absolute quantity of fertilising agents which form part of it is at any one time limited in its extent; and if the amount is augmented from time to time by atmospheric influence, there is also a limit to the additions to it from this source. It is, therefore, capable of being exhausted, and is undergoing this process as every crop is removed from the soil, whether it be potatoes, maize, or oranges. Furthermore, as the minor limit to the total amount of the elements of nutrition in the soil is being reached, so will the plant growing in this soil lack the possession of one or more of these elements to a greater or less extent ; it may have lost nothing of its robust growth, its fruit may be as large, and may even be as heavy ; notwithstanding, the chemist could certify in discovering the decrease in the proportionate amount in which a certain element was present that this plant had departed from its normal constitution ; and nature asserts the same fact when the plant, without apparent cause, becomes the victim of disease. Now, nowhere in Toowoomba is the soil subject to regular periodical enrichment at the hands of its cultivators, nor indeed generally is it manured* in any way whatever. It has not empirically been discovered there yet what enrichment plants require to enable them to grow in perfect health, nor inductively

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* We use this term in its most general acceptation, not necessarily meaning exclusively artificial manures, but including also different vegetable composts.

by taking into consideration the composition of the different plants in reference to the elements on which their nutrition depends, and the relation which this must always bear to the chemical and physical constitution of the soil. We are not prepared to point out, offhand, what manures are required in certain cases, or even to positively assert that any are required at all, but are content to state the *à priori* probability that they are; whilst at the same time we would insist on the fact that more harm than good may result from the application of manure to trees growing on ill drained land. These matters have been dwelt on simply because bad nutrition is often at the root of a great deal of the evil which such an inquiry as the present is called upon to investigate, although it is often difficult to point out the particular evil occasioned, or to what extent its occurrence is influenced by it. The system of cultivation of maize may be quoted as a single illustration, without unduly protracting our treatment of this theme. Now, this cereal is largely grown in the district, yields, on an average, when healthy, good crops, judged by the quality of *weight**; on the other hand, it is largely subject to disease.

It was pointed out on 7th February, by Mr. M. Stenner, of the Middle Ridge, as an instance of the fertility of the Toowoomba soil, that a particular piece of ground was then promising to yield a good crop of maize, although it had been cultivated for twenty-three years in succession and no manure had been placed upon it, although to some extent rotation of crops had been practised between maize—rye and potatoes. Now, a few days subsequent to this, as Mr. Stenner also informed us, disease visited this very maize. At another farm almost adjoining Mr. Stenner's—viz., that of Mr. W. Feljenhauer, of Alderley street, on which we found the "maize disease" very prevalent, the owner informed us that the ground on which this was growing had been cropped for the last seventeen years, and that no manure had been applied to it during all that time. And in other cases, whenever we commented on the unhealthy appearance of maize, although again very frequently the plants *looked* well enough and did not provoke any comment, it was usually thought a sufficient answer that—seeing that the ground had for so long a time done so well it should now be deemed satisfactory if it would still yield any crop at all; implying thereby their knowledge of the exhaustion of the soil due to cropping, and either their satisfaction in the existing state of things, or ignorance perhaps of the fact that they could be amended. The power of maize to impoverish the soil is well known. It has been stated that "maize is one of the most exhausting of crops, it being very rich in the most fertile elements of the soil—viz. magnesia, potash, and phosphoric acid. Compared with wheat its exhausting capacity has been found to be as 154 to 95 and more than one-fifth greater than potatoes." †

Under the heading "State of Cultivation" we might profitably have referred to the treatment of crop-yielding plants *per se*, collectively or individually. This subject is very pertinent to an investigation concerning plant diseases, and the illustrations of it afforded by a survey

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* This word is italicised, since we are of opinion that recent operations in America point to the conclusion that mere weight of the grain will shortly cease to be regarded as a measure of the value of a maize crop, which will come to be estimated by it, feeding capability as judged by its chemical composition.

† Report Secretary of Agriculture, Washington, 1862, pp. 266-7.

of the Toowoomba district are very suggestive of remark. Suffice, however, to state on this occasion that the proper care of plants, and a due regard to the best means for their propagation, have little influence on practice, and that comparative neglect as regards cultivated plants is the more prevalent occurrence in the Toowoomba district.

CULTIVATION OF PESTS.

Whatever attempts are individually made by fruit-growers to protect their crops from the attacks of insect or fungus pests, these efforts on their part will be rendered partly inefficacious, or even altogether futile, by the indifference shown in these matters by their neighbours. The expression of this opinion has been prompted by the fact so frequently observed at Toowoomba that trees, and not seldom whole cultivations, are abandoned to the operations of pests. It is quite a common occurrence to meet with peach trees growing isolated and neglected on the sides of paddocks, whose grub-infested fruit is allowed to fall to the ground and remain there, and thus a favourable opportunity given for the further development of the Tephritis fly. This neglect is especially reprehensible when it occurs early in the season, for it is mainly owing to the absence of measures for destruction of fruit damaged by the maggots then, that fruit, whose season for ripening is later on, suffers ; whereas even if pigs were allowed to consume this infected fruit as it fell to the ground, much good, no doubt, would result from their action. In a similar manner the existence of a vineyard, or even of a few grape vines, where the oïdium is allowed to spread unchecked, greatly augments the labours of any occupier of a neighbouring vineyard who has decided to adopt the sulphur remedy as a specific in contending with the mildew, and who would have enough to do without the existence of an ever present source for fresh infection. So, too, when some enemy to plants that has previously been unobserved first makes its presence felt, no effort should be spared to get rid of it, although it may not at this time occasion much concern. It is the neglect of this consideration, and an adoption of a *laissez-faire* policy, whilst meanwhile the pest is increasing with a geometrical progression that has been at the root of nearly all the damage that has been occasioned by the enemies with which the agriculturist has had to contend. We need only refer to the history of the invasion of the Cape of Good Hope, California, and New Zealand by the Cotton Cushion Scale, in illustration of this assertion. It is for this reason, therefore, that we have given more prominence than at first thought might seem needful to several of the insect or fungus pest observed already at Toowoomba, or which seem on their way to visit that district, since, although appearances may at first be in favour of the supposition that they will be comparatively innocuous, the circumstances existing to promote this view may at any time be removed or be relaxed in their operation, in which events the history which has marked their appearance and spread in other countries will be enacted also in this or in other parts of the colony.

INTRODUCTION AND DISSEMINATION OF PLANT PESTS.

Reference is made in the following pages of this inquiry to a few plant pests which, to the best of our knowledge, do not as yet occur in the Toowoomba district, although they are prevalent enough about

Brisbane, and exist also in other parts of South Queensland. Two even are referred to with more or less minuteness of detail—viz., the Codlin Moth and Mussel Scale of the apple, which have not, as far as we are aware, been yet established anywhere in the colony, but which are constantly imported on fruit which finds its way even to Toowoomba.

The insertion of the remarks relating to them is justified, as there is, therefore, some probability of their finding their way to the orchards of the district to which this report specially relates, and becoming naturalised in them as additional pests. To be forewarned of a coming danger is to be forearmed, and it is far easier to contend with the outposts of an advancing army, and so avert the main invasion, than to quell intestinal disturbance. It is profitable, therefore, to briefly state a few facts in illustration of the manner in which pests are and may be disseminated.

That there is positive danger of the insect and fungus pests of cultivated plants being conveyed from one district to another, and from country to country, is borne witness to by numerous legislative enactments which have been made in the neighbouring colonies, the intention of which is highly commendable, although they are generally rendered practically futile in their operation, insomuch as their purpose is to prevent the occurrence of what has already happened, and since, even if when fully administered, they could effect what it is intended they should accomplish—which is indeed very doubtful, their proper administration connotes the existence of so large and skilled an executive as is almost beyond the means of any country to maintain. Has legislation checked the extent of the ravages of the Phylloxera in Europe, or prevented its visiting the Cape of Good Hope? Has it served to stamp out this vine pest even in Victoria or New South Wales yet? In spite of the trite remark that everybody's concern is no one's, it seems that more reliance should be placed on the special intelligence of those engaged in cultural operations to effect for themselves what legislation has failed in accomplishing—viz., the protection of their own interests—their crops—from the attacks of disease, howsoever arising; and if they have not this special intelligence let enlightenment be brought them.

We have already received, on potatoes from the southern colonies, the destructive moth of that esculent, and it now occurs as a pest at Toowoomba. From the same source, too, but on apples, the Codlin Moth is brought here now and then, but much more frequently the Mussel Scale (*Mytilaspis pomorum*). On this fruit, as it arrives from California, we may occasionally notice the Round Black Scale (*Aspidiotus ficus)*, already too well established at Brisbane on quite an assemblage of different plants, but not as yet observable about Toowoomba. The Oranges from the same source are responsible for the introduction of two other scale insects attacking citraceous plants —viz., the White Scale *(Chionaspis citri)* and Glover's Scale (*Mytilaspis Gloveri*). Both these have already, on their approach towards Toowoomba, reached Highfields. We too are indebted to California for the larva of a beetle (*Cylas formicarius*, Olivier), the so-called "worm" of the sweet potato, unless perhaps this State and Queensland have received the pest independently from some source—the Mauritius. In our eagerness to improve the quality of our sugar-canes, we have brought here, from the Mauritius the "borer" (*Phalœna saccharalis)*,

and from Singapore—it is said—the "Pou a poche blanche." New South Wales, and Queensland indirectly, has received the Red Scale (*Aspidiotus coccineus*), from the Mediterranean countries, and the former colony has forwarded it on oranges to New Zealand, where, as here also, it is a well-known orchard pest. The common garden snail of Europe has been introduced to some of the towns of New South Wales, Victoria, and New Zealand, but has hitherto escaped being brought to Queensland, although a large slug, a species of Vaginulus, has arrived, and has become naturalised in our Botanical Gardens. Australia is credited with having sent the most formidable insect-foe of the orange—the Cotton Cushion Scale (*Icerya Purchasi*) to New Zealand, California, and the Cape of Good Hope. Could we discover the origin of many of the insect pests which affect our cultivated plants, this story might be largely amplified. Whence, for instance, has the Rose at Brisbane obtained its White Scale (*Chionaspis rosæ*) or its powdery leaf-fungus (*Oidium leucoconium*)? When came and how our Cabbage Worms, Aphides, Red Spiders, and *hoc genus omne*. The celebrated naturalist, Captain Hutton, has stated that there is no indigenous species of Aphis in New Zealand; but, is there a cultivated plant in that colony now that is not attacked by one species or other of this insect? These insect acquirements are inevitable, perhaps, owing to the commercial relations which exist between one country and another; but it seems that it should be morally imperative on agriculturists to check the formidable growth of plant pests, if not to stamp them out on their first arrival. Not only do we receive these pests without comment, but we even help their dissemination throughout the colony. Seldom, however, can be sent as companions with them, those parasites which prey upon them. Take the scale insects as an example. When Mr. Koebele, an Entomologist in the United States Agricultural Department, was searching the neighbourhood of Brisbane for specimens of the Cotton Cushion Scale, in order to procure its parasites for conveyance to America, where they might operate in checking its further spread, although his remarkable quick perception for the presence of insects did not lead him to discover them at once, elsewhere he had no difficulty in quickly finding what he was looking for on an *Acalypha* in the hall of the hotel where he lodged, on a plant which had been derived from a well-known local horticultural establishment. It is rarely that a disinterested party, capable of appreciating the fact, witnesses the transmission of plants containing pests to districts previously free of them; but how often, by an almost criminal act, are plants—especially young orange trees—so affected, "sent out." Quite recently we saw Crotons which had been received at the Brisbane Botanical Gardens for transmission to the Melbourne Exhibition infested with Black Scale, which had been doubtless acclimatised at the institution that had supplied these plants. These Botanical Gardens are a nursery for scale insects. Species may be obtained there not elsewhere procurable in the colonies. A few years since, one very remarkable member of this class (a species of *Ceroplastes*), an irregular tumid waxy pink-coloured insect, was noticeable on one or two shrubs immediately opposite the Houses of Parliament. At this period it might have been extirpated with little trouble; but now, through neglect, it has extended almost all over the Gardens, and is especially noticeable on some already well-known Mango trees growing in a quite central

situation. The risk of establishing this pest in our fruit cultivations generally should be strenuously opposed. In this scale insect all the worst features of the Coccidæ reside. Being comparatively a new arrival it has not yet been victimised by parasites, and is therefore most prolific; it is well nigh omnivorous in its vegetable diet; its thick covering of wax protects it from the action of the usual insecticides, and at the same time serves to secure it from the influence of climatic vicissitudes. Endowed with a well developed tubular excretory apparatus, it scatters tiny drops of saccharine fluid everywhere around it, and so determines the growth of a fuliginous fungoid substance all over the branches and leaves of the tree which it affects.

DISCRIMINATION BETWEEN FRIENDS AND FOES.

Although crops are subject to the attacks of so many insect pests, it is some consolation to know that these pests are not infrequently rendered comparatively innocuous owing to the occurrence of other insects which prey upon them. This fact in itself is a consideration on which the agriculturist may profitably dwell; and it has been remarked by one who has had occasion to give much attention to the relation existing between insects and cultivated plants, "that the ability to distinguish between friend and foe is of the first importance in coping with the latter, for it is a notorious fact that the farmer often does more harm than good by destroying the former in his blind efforts to save his crops."—*(C. V. Riley.)*

Taking a general review of the orders of insects, we find amongst the *Coleoptera* the entire family of Cicendelidæ or Tiger Beetles insectivorous, and nearly all the Carabidæ—two families of ground beetles which in Australia are represented by nearly a thousand described species. Then again there are numerous beetles here belonging to the families Malacodermidæ, Cleridæ, and Brenthidæ, also insectivorous, and finally the ladybirds, or Coccinellidæ, and allied forms, which in both the larval and adult states feed nearly every one of them upon aphides and scale insects. The importance of the last family of beetles to the cultivator of the soil can be scarcely overestimated. In California the work of ridding those parts of apple trees above ground of the so-called American blight is almost entirely relegated to insects which are members of the Coccinellidæ. Mr. W. G. Berkeley, of the Agricultural Experiment Station connected with the University of California, writing on the subject remarks, "A thorough treatment of the top was never made because we wanted to see how far we could depend upon the ladybird for exterminating these. From observations during the last few years I believe this, that in this locality this useful beetle can be depended upon for keeping the crown of the tree free from aphis *(i.e. Schizoneura lanigera)*. We cannot recommend too highly the protection of the ladybugs—Coccinellidæ. During more than one year we have seen them completely annihilate the aphis above ground in a few days: it is generally stated that their larvæ are the most destructive to the latter."* The scale insects in America are, too, largely preyed on by Coccinellidæ belonging to the genera Cycloneda, Chilocorus, and Hippodamia, and Mr. H. G. Hubbard informs us that "One of the smallest of this

* *Vid.* "Report of the Entomologist." Rep. Department of Agriculture for 1881-2. Washington 1882; pp. 204-206.

family, Hyperaspidius coccidivorus, is found to colonise upon the trunks of orange trees thickly infested with Chaff Scale, and entirely free them of the pest.*

In Queensland the Coccinellidæ beetles perform equally serviceable work. Wherever aphides exist, there there are ladybirds in the larval or adult condition to feed upon them. Notwithstanding this being so, no instance of the recognition of this office which they perform has ever here been brought to our notice; but on the other hand, an identity has been alleged to exist between them and the plant-eating coccenellid of the potato and pumpkin—a species of Epilachna, and accordingly, being regarded as insects similarly destructive with it, they have been intentionally destroyed. It is, however, for destroying our Scale Insects that the Coccinellidæ are here most highly useful. To mention but a single instance, that of a small black beetle reddened at each extremity, belonging to the group Scymnites, and named Cryptolœmus. The larva of this is a small active grub, measuring about ¼-inch in length, covered above with six rows of contiguous elongated white mealy secreted appendages. Quite recently the Bunya Bunyas, and other auricaraceous trees growing about Brisbane, have been infested by a Coccus insect—an apparently undescribed species of Dactylopius which affects especially the spot where the leaves and branches unite, and the parasites were at one time so numerous that the death of these valuable trees from their attacks seemed very imminent. However the Cryptolœmus beetle also visited the Auracarias, and in some places its larvæ occurred in such profusion that the trunks of these trees, and the ground around their bases, looked as if flour had been dusted in patches here and there upon them. Both in its adult and larval condition it waged war upon the Coccid insects, and as a result these trees are saved from destruction. This friendly insect is none other than the one which is met with on various native trees, especially Acacias, and also on the citraceous and other economic plants of our gardens. These also it visits for the purpose of ridding them, or at least checking the increase of the various scale insects, especially those belonging to the Lecanidæ which infest these trees, and these pests it literally mows down to the surface of the leaf, so great being its voracity. That such an obvious fact should have escaped observation here (and elsewhere perhaps also), or even comment, seems scarcely credible, and yet it is so. Further than this, wherever we have been, either at Toowoomba or at Brisbane, the larva of this insect has been regarded as the Mealy Bug (another Coccid unhappily becoming now too prevalent about Brisbane), and, under a mistaken idea, destroyed by those who make a practice of killing destructive insect visitants to their crops. Moreover it has even been suggested to us by one who had seen that insect, that it was none other than the Cotton Cushion Scale (*Icerya Purchasi*).

In the order *Hemiptera*, or bugs, there are again several predatory insects, belonging especially to the families Halydidæ, Piratidæ, Reduvidæ, and Harpactoridæ. We have observed an orange tree to be entirely freed from the presence of the destructive caterpillars of Papilio anactus, by insects belonging to the genus Halys, which lived by implanting their rostra or probosces into the tissues of these pests and then imbibing the fluid constituents of them. Other instances

* Ib., p. 109.

might be mentioned in illustration of the utility of insects of this family to the fruit-grower, who seems never to discriminate between the vegetable and animal feeders which it contains, until perhaps he has learnt to do so by painful experience. For it only bespeaks the carnivorous habits of one of these, a species of Pristhesanchus, which frequents orange trees, when this tree-bug inserts it's rostrum into his fingers on being handled.

There are many useful insects, again, which are included in the order of *Hymenoptera*. There is the large orange and black insect with stalked abdomen—Eumenes Latreillei—which fills the cells of its mud nest with caterpillars as food for its own larvæ. The great silvery black restless wasp—Sphex ephippium—may frequently be noticed carrying off large insects to its subterranean nest, where they are to serve for a like purpose. A young grasshopper is not too great a burden for it to bear off. The large, often yellow and black striped Scolidæ are again enemies of grasshoppers and other insects. Amongst ants, too, we have many friends; and we need only mention in confirmation of this assertion the family Poneridæ, whose members, often nocturnal in their habits, are exclusively feeders on animal matter, and especially prey on insects. The great family of Ichneumonidæ is too well known to need more than a passing remark. In 1873 it was brought under the notice of the Secretary for Agriculture, Victoria, that one of these insects—viz., Bracon capitata, was a very effectual enemy to the grasshoppers, one informant stating that he had "noticed that when the locusts were most numerous this Ichneumon fly was to be seen in greatest force." Count Castlenau, the celebrated entomologist, in reference to this insect, stated also,—"this parasite is most important, as I believe it will be to it alone that we may one day owe the disappearance of the locust." We are often asked, in reference to the disappearance of countless caterpillars or grasshopers from any one locality, where are they all gone to? Now, our discovery that a very large percentage of the eggs of the grasshopper—both of that one which occurs on the Darling Downs, and of that which eats up the sugarcane on the Herbert River—are parasitised by an hymenopterous insect seems to dispose of the inquiry. In the same hymenopterous family are, in conclusion, the many minute insects belonging to the Proctotrupidæ and Chalcididæ which deposit their egg within the eggs of insects or in the bodies of insect larvæ or caterpillars. The Scale Insect are especially subject to be attacked by parasites belonging to the first of these classes. It sometimes happens that one of the naturalised species of Lecanium is so infested that scarcely a single individual escapes destruction. To the eye of the expert the assumption of a darkened hue by this coccus indicates the presence of the parasite within it, and when such occurrence prevails he may advantageously forego the use of insecticides intended for the destruction of the scale insect and rather trust to Nature's remedy.

For a long time the family of Lepidoptera, which includes the moths and butterflies, was, except in the case of those members of it which display a taste for horn, hair, fur, and wool, regarded as living when in the caterpillar state entirely on vegetable matter. It is now known that in England the caterpillar of a small moth attacks chrysalis cases of other lepidoptera which have been deposited in the ground. In Queensland, too, we have observed that a similar moth is equally

destructive to the pupa case of the potato-leaf-eating Epilachna. The most remarkable case, however, is that of a moth which in Australia rids us in great measure of our Scale Insects. Public attention was first directed to its occurrence by Mr. G. Masters, at a meeting of the Linnean Society of New South Wales, held in 1885, at which he exhibited some small moths (afterwards named *Thalpochares coccophaga*) bred from caterpillars found feeding on a Coccus which infested the common Zamia. "These caterpillars," Mr. Masters remarked, "in the course of a few days completely cleared the plant of the scale, devouring the Coccus and forming with the scales or empty skins complete coverings for themselves, which they carried about on their backs. They fed at night, and during the day fixed themselves securely to the midrib of the frond." Now this useful insect is exceedingly common both in the Toowoomba and Brisbane districts, and is probably widely represented in Southern Queensland. It also has as congeners one insect, of similar habit, which we have remarked consuming the white scales (*Chionaspis citri*) on the orange trees at Highfields, and the other commonly feeding on the semi-globular reddish-coloured coccus of the Eucalyptus at Brisbane. Every tree in these districts which is infested with Black Scale (*Lecanium oleæ*) will afford examples of *T. coccophaga*. Strange to observe, we have never met with one in this colony who has recognised the rôle of this insect. Whenever at Toowoomba we sought typical examples of the Black Scale for study we were directed to examine the angles between the branchlets of the orange tree for "extra fine examples" of the Coccus we were in quest of. Indeed we found more than once that these alone remained, together with fumagine, to attest the previous occupancy of the trees by the Scale Insect in question. In these instances the species of mimicry which nature had evidently wrought (with such perfection as to effect in this caterpillar a resemblance to extra fine examples of the Black Scale) to serve for this caterpillar as a safeguard from destruction at the hands of the ordinary foes of insect life, tended only to ensure its being killed—its utility being overlooked."*

Gardeners have, too, great friends amongst the *Diptera* or two-winged flies. There are the large rapacious carnivorous insects belonging to the Empidæ and Bombylidæ which carry our insect pests bodily off. Then there are the curious larvæ of the balancing flies, the Syrphidæ, which feed on plant-lice, and which are so common that no collection of Aphides will probably occur, especially on maize, which does not also include examples of these apidovorous insects. Amongst dipterous parasites, which live within their hosts, we may mention the species of *Tachinus*, large insects shaped somewhat like common house flies with greyish banded hind-bodies. These may be often noticed suspiciously prying amongst the leaves of citraceous trees in quest of the large caterpillars of the Papilios which feed in this situation, and their eggs deposited on these caterpillars develop into larvæ which prevent the chrysalises from hatching out. Perhaps, however, one of the most remarkable parasitic Diptera is a small insect which in the grub condition feeds within the redoubtable Cushion Scale

* *Vid.* "Notes on the Parasitism of Certain Lepidopterous Insects," by J. O. Westwood. *Tr. Ent. Soc. London*, 1887, pp. 433-437; also of. *P. E. Soc. Lond.*, 1877, pp. xviii. and xix.

(*Icerya Purchasi*). This Mr. Frazer S. Crawford discovered a short time since at Adelaide, and brought to the notice of the United States Entomological Department. Professor Riley, the State Entomologist, was so impressed with the importance of this discovery that he conceived the idea of introducing this parasite, which meanwhile has been named *Lestophonus iceryæ* by Dr. Williston, into California as a check on the undue increase of the Cotton Cushion Scale, which was destroying the orangeries there, just as he had previously done with the European *Apanteles glomeratus* for contending with the cabbage-eating caterpillar of the butterfly Pieris rapæ. And he has recently dispatched Mr. A. Koebele, an experienced entomologist of his department, to the Australian colonies for the purpose of transmitting the *Lestophonus* to America. Mr. Koebele visited Brisbane in prosecution of his mission, and informs us that he has been so far successful that this dipteron has been hatched out in quantity in California from parasitised examples of *Icerya* which he sent thither. The results attending this interesting venture will be looked forward to by the scientific world with considerable interest.

Other orders, too, present us with insect parasites and enemies. There are dragon flies, the ant lions, the mantis, and the lacewing flies or Chrysopidæ. The last mentioned when in the larval state are, like the Syrphidæ, great devourers of Aphides. Curious to relate, as illustrating their habits, they place their own eggs at the ends of erect and most delicate threads as if aware of the ills to which, in their own instance, insect flesh is heir to.

PROTECTION OF NATIVE INSECTIVOROUS BIRDS.

What is so noticeable about Brisbane is especially to be remarked on in reference to Toowoomba, that is the great dearth of native birds. You may walk through many of the gardens about the town, where every circumstance would seem to favour their presence, and not see one. Certainly the occurrence of an abundant fruit supply does oftentimes determine there, the congregation of Leather Heads,* Green Leeks, and other Parrots, Blue Jays,* and more rarely, in some remote cultivation, the grapes are pierced by tiny Spinebill Honeyeaters. This is as far as frugivorous birds are concerned; but where are all the insectivorous birds that used to be so numerous, as we were informed, in the Toowoomba gardens in years gone by? Has not an abundant food-supply, though of an entirely different nature, a similar attraction for them? It has; and they once visited the gardens and bred there to support both themselves and their young on destructive and other insects; but season after season they have been ruthlessly shot down, or their nests robbed by those whose intelligence is young, but not always with the youth of years. Such destruction of insect foes cannot be too strongly deprecated. It was brought under our notice at a very early stage in this inquiry indeed, and at the local show of agricultural produce, held on the 27th January, there faced each other as competitors for honours in the different classes in which they were respectively exhibited, (1) Collections of eggs, chiefly these of insectivorous native birds, in which each of the different species represented was illustrated by

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*These two birds notwithstanding these proclivities are two of the best destroyers of insect grubs which we have in our bird fauna.

several specimens; and (2) more than one assortment of what was denominated the best collection of fruit grown in the district, all of which collections possibly—so insidious are the attacks of insects—as one certainly did, contained, hidden to view in the tissue of some of the samples which they comprised, insects which by their development would render the fruit which they infested worthless—insects which it is the function of certain birds, the eggs of which were exhibited, to destroy. It has been well said:—

"If the arrangements of nature were left undisturbed, the result would be a wholesome equilibrium of destruction. The birds would kill so many insects that the insects could not kill too many plants. One class is a match for the other. A certain insect was found to lay 2,000 eggs, but a single tom-tit was found to eat 200,000 eggs in a year. A swallow devours 543 insects in a day eggs and all."

In the United States the rôle performed by insectivorous birds is, perhaps, now well appreciated after many legislative measures*. In the Australian colonies, too, measures have been adopted for the Preservation of Native Birds (witness in Queensland "*The Native Birds Protection Act of* 1877," and its Amending Acts) which have not entirely confined their attention to those which feed the markets. The Secretary for Agriculture, Victoria, has delivered himself of this opinion:—"The absolute necessity for strictly preserving all insect-eating birds in this country, where the plagues of the locust and caterpillar are of so frequent occurrence, and where insect blights are yearly becoming more and more prevalent, is a matter which demands earnest consideration, and one which should receive attention at the hands of the Legislature."† In Europe we may point to the discussion which arose in the French Chamber in 1861 when, at the instance of the Minister for Agriculture there, a commission was appointed to inquire into this matter and report on what legislation was expedient. The importance of the preservation of native insectivorous and other birds has not, however, engaged the attention of statesmen alone; it has long been proclaimed by observant naturalists, and many facts pointing to its necessity might have been adduced from our own experience. We are aware, however, that there have been some, with M. Eduard Perris for their leader, who have made light of the office which they perform; but for our part we are amongst those who would concede a value even to the house Sparrow as an insect destroyer, and everyone who studies birds would do the same. It is a significant fact in our eyes that one of the latest writers on birds generally, Arévalo, prefaces his great work "Aves De Espana" (Madrid 1887), as if with an epitome of their whole external relations, as far as we are concerned, with these well known words of the justly celebrated Chenu:—

"La destruction d'un grand nombre d'espèces d'oiseaux entraine-t-elle le développement de myriades d'insectes qui dévorent les fleurs, les fruits, les céréales, la vigne, et même les arbres des forêts."

We have dwelt on these matters since we are of opinion that, owing to the fact of penalties imposed by Acts of Parliament for the Preservation of Native Birds being so difficult to allocate, much greater

* For a summary of the different Acts relating to the preservation of birds recently in force in the several States of the American Union, consult the Report of the Secretary of Agriculture, Washington, 1864, pp. 431-446.

† "Report Secretary of Agriculture," Melbourne, 1873, p. 70.

results may be accomplished by an intelligent appreciation of the function subserved by birds in the interests of agriculturists, and at their hands, than by legislative measures. That the army of these insect foes, to which Toowoomba culturists may look for succour, is somewhat heterogeneous in its composition, if not numerically strong, may be gathered from a perusal of the List of Insectivorous Birds of Toowoomba, given in an Appendix to this Report. Its variety points to the probability of its food being as variable in its nature as are the insect pests themselves; its weakness in individual numbers to the necessity of protecting it.

CHAPTER I.

Resume of the Chief Varieties of Fruits Growing at Toowoomba, the Extent to which they are Cultivated, and the Diseases to which they are Subject.

APPLE.

The apple is largely grown in the Toowoomba district. Mr. H. Roessler, on his Gowrie Creek Estate, has quite a thousand trees; and at Ballard's Camp Mr. Holmes has perhaps as many. Most of these are so-called American blight-proof varieties, or kinds which have been grafted on blight-resisting stocks, such as the "Northern Spy" and Winter "Majentin." Toowoomba seems well adapted for the apple. Amongst principal kinds raised there the following were noticed:—Billy's Red Streak, Claygate Pearmain, Summer Pearmain, Winter Pearmain, Frompton's Seedling, Gladney's Red, Hockings' Greening, Irish Peach, Jeptha's Surprise, Kittages-kee, Red Astrachan, Stephenson's Winter, and Trivet Seedling.

The principal insect enemies of the apple are the Fruit Fly and the American Blight. In addition to these, in some seasons, a *fungus* (*Glœosporium fructigenum*) does much damage to the ripening fruit by producing a gangrenous affection; the foliage is often eaten by the caterpillars of two moths belonging to the family *Geometridæ;* and the *caterpillar* of a third moth bores the wood. Formerly the apple trees in Toowoomba suffered much from the attacks of the American Blight. Mr. Hertzer, of Hume street, planted quite a number of trees twenty-one years since; now all have been killed by this pest save one, which, although blighted to the tips of its branches, still bears fruit.

At "Paradise" Estate, Mr. Hanley once obtained, annually, four tons of apples from his trees; now they are nearly all gone, sixty trees having succumbed to American blight in a single year. The losses of others on account of this pest have been equally great. The majority of growers now confine their attention to blight-proof varieties of apples; others are of opinion that land situated with a certain aspect, and accordingly subject to the influence of particular winds, is unfavourable to the spread of this pest, and so can extend their selection of apples so as to include more of the better varieties than they otherwise could. Amongst those who favour this view is Mr. H. Roessler, and he has made such a selection as is above alluded to in his Gowrie Creek orchard, which has a southerly aspect and is also

more exposed than are the generality of gardens nearer Toowoomba. The trees there were all young, but although many had been planted out five years and were bearing well, no sign of the American blight came under notice. Many in the district infer that the term "blight-proof" signifies absolute immunity from the American blight, whereas those who adopted this expression intended to imply by its use not only those trees which maintained complete freedom from this pest, but those also which, although subject to it, were only injured to a small extent, and were still competent to bear fruit. The Summer Pearmain and Stephenson's Seedling illustrate the meaning of this statement. Neither do American blight-proof apples—nor indeed any apples grown in the district—escape the Fruit Fly, which seems especially to affect this fruit—a conclusion based both on testimony, observation, and experiment. There is reason to infer that the attack is often made by the fly in the first instance before the fruit has attained its full size, an occurrence which is not so generally remarked in other fruit. The earliest as well as the latest in season are subject to the same injuries. Even Gladney's Red, one of the first apples to ripen, is often destroyed by the larvæ of this pest, as was stated by more than one.

No instance of the occurrence of that great pest of the apple, the Mussel Scale—*(Mytilaspis pomorum)* was met with in the district, neither does it appear that it has been yet observed by any one there. The same remark applies to the Codlin Moth. The Mussel Scale, however, finds its way to this colony on apples imported from the southern markets in plenty, and during the prosecution of this inquiry, a Tasmanian Apple containing the larva of the Codlin Moth was purchased in one of the Brisbane shops—as might often be done. Now, as Tasmanian and other southern fruit finds its way also into this fruit-growing district of Toowoomba, the risk of infecting the apples there with these pests is very great. Apple-growers there should, then, be armed in advance with a knowledge of the appearances and habits of these insects, as well as of the methods in vogue for their destruction.

PEAR.

No orchards in Toowoomba are devoted exclusively to this fruit; nevertheless, there are a great many pear trees in the district. The different varieties, too, grown are very numerous. Those which came under notice were the Beurré Clairgeau, the Chaumontel, the Chines Sand or China Pear, Honey Pear, and a Bergamotte, and others whose names could not be ascertained.

The chief enemy of the pear at Toowoomba is the Fruit Fly. Some of the early fruit, however, escapes in seasons when the later pears are badly affected. This was the case this season with what was described by Mr. Noss as a longish-shaped pear, ripe before Christmas. Those pears which do not develop much saccharine matter on the tree, or are otherwise of a very dense and hard nature, do not seem to be injured by the Fruit Fly. A large baking pear, with coarsely dotted skin, commonly grown in the district, is a case in point. Conversely those pears which are of a more soft and delicate structure are the worst attacked, as for instance, a light yellow fruit of medium size, which was ripe on the tree this season (1886-7), during the last week in January, but which is usually two or three weeks earlier.

In a similar way to the apple, the pear in the district is also subject to the attacks of a fungus *(Glœosporium)* which is especially prevalent in wet seasons. When the fruit is quite green the coffee-brown spots, and in later stages blotches—the symptoms of this malady—are very conspicuous, and occasion in the fruit quite a gangrenous appearance. Sometimes these manifestations follow wounds occasioned by the Fruit Fly or other insects, or such as are merely mechanical, but in many cases there is reason to think that the affection arises quite independently of any such origin.

Some varieties of pear, especially the Bergamottes, are very subject to *splitting*, and this was especially so during the wet season 1886-7.

Mr. Searle described a disease manifesting itself in the foliage by the following characters :—

"The leaves get black spots, which increase in size rapidly till the whole surface is of this colour. This occurrence causes the leaves of a tree to almost entirely fall." Mr. Searle has remarked "that this affection usually commences on the north-west aspect of a tree, and often long before the fruit is sufficiently matured to be gathered."

No opportunity was discovered for investigating the nature of this affection.

The fruit of one tree was observed to be small and irregular in shape, having failed in some places to develop its usual symmetry. In shallow depressed areas, on the surface of these pears a scarcely evident green matter, resembling the reproductive organs of some fungus, was noticed. By accident this fruit escaped further investigation. Whether there was evidence here of the existence of the disease of the pear so common in South Australia, viz., the *Fusicladium*, cannot be positively affirmed.

Pears are much subject to the pilfering of the flying fox, and these animals seem very partial to the fruit, even when hard and green. Mr. Lowe (gardener to the Hon. J. Taylor, M.L.C.) reported their having taken quite two bushels of hard baking pears from a single tree in one night.

QUINCE.

Quinces, also, are grown in considerable number in the Toowoomba district, although there are no orchards exclusively devoted to this tree. During the present season (1886-7) Mr. Bushnell was disposing of his crop in Brisbane by the ton. The pear-shaped quince seems to be most commonly grown, though the other varieties of this fruit are to be met with. The fruit commences to ripen on the tree early in February. The quince seems to be subject to insect enemies, but only to a limited extent. If left hanging too long on the tree the Fruit Fly will commence its depredations upon the fruit, and Mr. Searle has even observed that this pest begins to attack the fruit long before it is ripe, affecting the core ; but the results of our experiments have not been such as to confirm this observation. We would, however, suggest that the fruit be gathered in as soon as by the disposition to shed its pubescence, and the colour of its pips, it manifests the fact that it is sufficiently matured to permit of this. The quince is also subject to being infested by a white *coccus insect;* but this, as Mr. Hartmann remarked, seems to confine its operations to the so-called "wild

quince." In some gardens it was noticed that the leaves had been superficially eaten by some insect. This pest, although only observed by its effects, was not the "Slug-leach," a saw-fly larva.

PEACH.

Raised from the stone with such facility, coming into bearing when only three or four years old, and a prolific "cropper," are facts which afford reason sufficient why, in the Toowoomba district, the peach tree should be such a general favourite. There are no peach orchards there, but this tree finds a prominent place in every fruit garden. No cottage with its small plot of cultivation but has two or three peach trees growing by it, or they may have been planted along the fence of the paddock. Thus it happens that the failure of the crop, even to a partial extent, involves the community there in considerable loss, and one, moreover, difficult to estimate.

Commencing with the Flat China Peach, which fruits as early as November, there is a succession of different varieties of peach until well into March. Indeed, there is one kind—the Julia—as Mr. B. Crow informed me, which is not ripe until nearly May. The principal well-marked varieties grown appear to be:—1. A large China flat, at Raceview; 2. the ordinary China flat, ripe in second week in December; 3. Weeping peach, ripe in December; 4. Royal George, ripe during January; 5. Shanghae, ripe towards end of January; 6. several indeterminate slipstone peaches usually "bloodstones," ripe during latter weeks of January and well into February; 7. Solway, ripe during March; Yellow Monday, ditto. Other good peaches grown in the district are: Alexandra Noblesse, an early peach; the Amelia and the Comet, ripe end of February and March.* The China flat, Royal George, those included in 6, the Solway, and Yellow Monday are, however, the principal well-marked varieties grown.

The chief enemies of the peach in the Toowoomba District are the common "maggot," "worm," or Fruit Fly; a less common similar affection due to attacks of a small black fly; gumming; premature shedding of foliage due to the presence of a fungus, Uromyces amygdali; curl in the leaf; red spider; Bryobia; aphis; black scale—Lecanium oleæ and fumagine; fruit borer—the caterpillar of a moth, Conogethes punctiferalis; borer in wood—a beetle larva, Orthorhinus sp.; a caterpillar eating into surface of unripe fruit, Fam. Noctuæ; and perhaps also the common white peach scale—a Chionaspis, of the Brisbane district. When the fruit is ripening if still left on the tree it is at the mercy of what are known in the district as weevils, viz., beetles, including species of Brachypeplus, Calandra, and an undetermined staphylinidid insect. Compared, however, with the injuries inflicted by the fruit-fly, those occasioned by the other pests, though in themselves bad enough, are insignificant, and claim little consideration. With the exception of the China flat peach, which is usually free from the attacks of the "worm" by reason of its being such an early fruiter, and the first gathered of the Royal George peaches—free from the same circumstance, it would seem that all the numerous varieties of peach grown are addicted to the attacks of this enemy, neither would it appear that any degree of cultivation or neglect has any direct

* All fruit during season 1886-7 was somewhat backward, and in other years these different peaches have ripened their fruit two weeks earlier.

influence in modifying or preventing its incursions. Whatever methods are resorted to in order to effectually contend with this pest, they can only be of a preventive nature, and their application will involve some outlay. Most of the peaches grown now in the district are of a very inferior quality, and it is doubtful whether the absolute quantity represented in the peach harvest would, in view of this fact, allow of the profitable use of such preventive remedies. But by better cultivation better fruit can be raised, for which a market is always open, and at which prices realised will permit of any additional outlay occasioned in securing such a fruit.* It is a well-known fact that the presence of the codlin moth in the orchards of America has had the effect of improving the quality of the apples raised there.

With few exceptions, the following is the manner in which peaches are grown in Toowoomba. Nearly all the trees are seedlings and unworked, and if additional trees are required stones are taken haphazard from the fruit of one or other of these, according to the variety that it is wished to propagate, and so on for a third generation of peach trees. The ground about these is not tilled in any way, unless it be for the admission of some other exhausting crop. They are never manured. They are not pruned or shortened in at all. Whilst they last they are allowed to bear excessive crops from the very first year of their fruiting, under the mistaken judgment that a numerically large crop is the more profitable. Those who have studied the subject are agreed that all the different varieties of peach have been produced by systematic cultivation from a single and very inferior kind; and although the different races do reproduce themselves truly by seed, it is a well-ascertained fact that if allowed to grow wild, as in the greater number of cases in the Toowoomba district, the constitution of the peach tree, as well as the character of the fruit will, through successive generations, be gradually modified from better to worse; in fact, a reversion will take place to the characters presented by the original parent tree. This fact is nowhere so well illustrated as in New Zealand, where the excellent varieties of peach introduced by the first missionaries have become degraded—as in the progress of "civilization," the agricultural pursuits of the natives, the outcome of a habit almost innate in them, have been supplanted by others with different tendencies. That serious malady, too—the yellows—which decimated the peach orchards of the United States during the first two decades of this century, has been attributed also to the same system of neglect.†

Under this same system, then, it is a common observation that the peach tree in the Toowoomba district will last, according to different estimates, from fifteen to twenty years—this is the term of its longevity. Long before this limit is reached, however, it is probably only cumbering the ground. When it shows signs of decay, it is recommended that it should be rooted up and its place supplied by a fresh

* The highest price obtained this last season for peaches at Toowoomba was perhaps 3d. to 4d. per dozen. This was for the Royal George peach. Some varieties realised as little as 1½d. per dozen. Whilst for others there was absolutely no market. On the other hand, during the progress of this inquiry, and when no sound Toowoomba peach could be obtained in Brisbane, superb Melocoton peaches from elsewhere were being retailed in this city at 4d. apiece. This was on 15th February, 1887.

† "The Fruit and Fruit Trees of America," by A. J. Downing, New York, 1870, p. 509.

seedling, perhaps raised from its own fruit and inheriting from it all its acquired constitutional weakness. And even if it does not repeat this character, a long time is occupied in growing peach trees of full size. In other countries, peach trees, when regularly pruned and manured, are known to have yielded excellent fruit during sixty or a hundred years. At the outset of this inquiry, we would recommend, then, that attention should be paid to the desirability of improving the quality the fruit at present exhibited in the different varieties grown; and also to the introduction of others, especially such as are known to come early into bearing.

NECTARINE.

The nectarine is grown to no large extent at Toowoomba. Amongst those which claimed attention were the Victoria and Stanwick's Seedling, the former ripe about the last week in January, and the latter usually, perhaps, perfecting its fruit a little later. Being so nearly related to the peach, these two fruits are subject to the same pests and diseases; but owing to the possession of a smooth skin, the nectarine is much addicted to the attacks of the Fruit Fly, as was especially demonstrated by our raising this insect in numbers from fruit supplied by the Hon. W. H. Groom, M.L.A. The nectarine, however, especially the latter of the above varieties, suffers greatly from splitting, and in this respect it differs from the generality of peaches. The following appearances were noticed in nectarines which, as afterwards proved, were infested with the maggots of the Fruit Fly. The fruit looked perfectly sound, save for the presence in each example of a slightly softened area on one side, in which a minute puncture was contained.

APRICOTS.

Apricots were already out of season at the time when this inquiry was commenced. In no part of the district of Toowoomba does it appear that they are grown in any quantity. Three kinds or varieties were brought under notice—viz., (1) fruiting at the commencement of December; (2) coming into season at the end of that month; and (3) a variety with small fruit. The apricot varying under cultivation in an analogous manner to the peach, requires similar attention, if good fruit is a desideratum. Its chief enemy at Toowoomba is probably the Fruit Fly (*see* "Peach"), but those apricots which come early into bearing escape this pest, as do also the earliest ripe of those varieties which are in season later on. But, as with other fruit, the attacks of this fly are influenced in their occurrence by prevailing meteorological conditions. In reference to this statement, the following testimony of Mr. Bushnell, of Isaac street, one of the oldest and most extensive fruit-growers of the district, is of interest. Three years ago (*i.e.*, in 1884), at the season of fruiting he had some very fine examples of apricots, and on Separation Day (10th December) of that year, he took some samples of this fruit with him to Ipswich and Brisbane in order to obtain a market for it. On the strength of the appearance of these samples he got such large orders that he was induced to advertise for the purchase of additional apricots wherewith to meet the demand of his customers. All his apricots were, as he thought, perfectly sound, but immediately following the 10th there were two hot days in succession, and on his return he discovered that his entire

apricot crop was infested with the maggots of the Fruit Fly, and thus at once he lost fully £40. This is an instance, also, of the insidiousness of their attacks.

In addition to this pest, the apricot is also subject to gumming, and some trees have the character of being unfruitful—a feature which might with some certainty be remedied by heading back and budding. Mr. B. Crow, an experienced gardener, resident at Toowoomba, attributes the unfruitfulness, to the apricots being generally budded on plum cuttings instead of on seeding plums, with the result that the tree yields abundance of plum suckers at the root, but comparatively little or no fruit. In England and America, apricots are budded on the plum, usually the Mussel Plum, but always on seedlings. Mr. Bushnell has several seedling apricot trees bearing fruit, as he assured us, of excellent quality.

ALMOND.

Almonds are little grown in the district, no garden perhaps containing more than three or four trees. These belong to both the hard and soft shelled varieties. As far as could be learnt, these trees are cultivated exclusively for their fruit, and not for any product which this might be made to yield—no almond oil being expressed.

Being so closely related to the peach, it might have been anticipated that both the almond and it would be subject to the same diseases, and this is more or less the case.

Nowhere in Toowoomba is the yield of almonds anything but poor, and this is no doubt accounted for by the fact that it is constantly being denuded of its foliage, a state of things which at first seems somewhat remarkable.

This shedding of the leaves was noticed or pointed out on more than one occasion during the progress of the investigation. Mr. Gregory drew attention to some trees which had borne no fruit during the season, but which had shed their leaves twice; and Mr. H. Hopkins, gardener at Spring Lawn, stated that the almond trees there had shed their leaves directly the fruit was on them. This phenomenon, which is further alluded to in dealing with the diseases of the peach, was found to be exhibited only when the yellow spots, so characteristic of the presence of the fungus Uromyces amygdali, occurred numerously on the foliage. The almond tree also is very subject at Toowoomba to gumming, and in some places in the district the flying fox carries off a great portion of the crop prior to its being fully ripe.

PLUMS.

Plums are grown in the Toowoomba district in considerable variety, and although there are no orchards exclusively devoted to this fruit everyone perhaps has a few trees. The principal kinds appear to be the Yellow American Plum, the Red American Plum, the English Blue, the Wild Goose, the Early Green Gage, the Common Quetsche or Sweet Prune, the Golden Drop, the Yellow Egg, the Purple Gage (Magnum Bonum), Green Gage, and a small round blue plum. These are enumerated in about the order in which they come into season, although a few kinds ripen their fruit at the same time. The Yellow American is the first and is succeeded by the Red American, which

ripens its fruit just about Christmas; the Wild Goose is another Early Plum ; the remaining varieties were some of them carrying their fruit until the end of the first week in February.

Some of these plums are in the spring of the year affected by aphis, and amongst them is the Wild Goose. The plum is always subject to the attack of the Fruit Fly, although this fruit does not seem a favourite with the pest. Only in one instance were the American Plums reported to have been attacked by it, and in this case to a slight extent only. Those plums which immediately followed these were also not subject to it, or only the latter portion of their crops was. Experiments demonstrated the fact of yellow coloured plums being selected in preference by this insect to those which were purple or otherwise coloured. The degree in which they contained saccharine matter also influenced the occurrence of this pest,—for instance, no case of Damsons being affected was either noticed or commented upon ; but those purple or blue plums which were addicted to splitting, also often harboured the maggots of the Fruit Fly.

This *splitting* itself caused considerable loss to those who grew plums to any extent. Green Gages, in addition to Purple Plums, are subject to it. When the fruit is left long on the tree it is attacked by insects locally known as weevils (*Brachypeplus*, spp.), and also by the wine or Pomace Fly (*Drosophila*, sp.).

No indications which would lead to the inference that the American Plum Weevil or Curculio (*Rhynchœnus Nenuphar*), or any insect having similarly destructive habits with it, were forthcoming. Neither were instances in which Black Gum or knotting affected the trees, noticed or spoken of. One instance of a young plum tree dying with characteristic suddenness was met with. This was the case of a large blue-fruiting plum, which usually ripened its fruit soon after Christmas. This season the tree had died suddenly, with its leaves and fruit still on, as was observed when it was brought under notice. No premonitory symptoms of this sudden decadence had been forthcoming. On digging up the tree it was seen that the trunk had rotted all round just beneath the ground, and that the white mycelium of a fungus was spreading over this decayed portion, and also extending to the roots. On splitting the trunk it was found that this decay had extended right through, but what was remarkable was that the very heart of the tree was occupied by a well defined narrow elongated tract of rotten and dry wood which had completely broken down to powder (dry-rot). This tract connected in no way with other portions of the trunk, and did not lead into the roots. This dry-rot had evidently caused the death of the tree, but what had at first initiated it did not transpire. At first it had seemed that this affection was in some way analogous to the "foot-rot" of orange trees—instances of which appeared in the same garden. The late drought, long after it had passed by, might, on the other hand, have been still only asserting its influence.

Mr. Hopkins drew our attention to the ill effect on the plum of propagating this tree by grafting it on the apricot. The plum trees were now comparatively unfruitful, and the apricot stock was manifesting its incompatability with its scion by utilising its energies in growing suckers all around.

CITRACEOUS PLANTS—Orange, Lemon, Citron, &c.

Citraceous trees are both extensively and generally grown in the Toowoomba district. No garden is, perhaps, without one or more orange trees, and some estates are exclusively devoted to their cultivation. This is especially so in the case of Mr. Roessler's orchards in Crown street, and on the Highfields road, and Mr. Hitchcock's, at Mount Pleasant, each of which are many acres in extent. The variety of oranges grown, for immediate profit alone, is very great. In addition to this, Mr. Holmes, in order to discover which are the kinds best adapted for the Toowoomba climate, has brought together, at Ballard's Camp, all the different named oranges that he could obtain in Australia, some thirty-eight in number. The principal varieties of citrus plants met with in the district were (1) of *Citrus aurantium*, the Parramatta, the Navel, the St. Michael, the Cluster, the Selecta (otherwise written Siletta or Selleta), the Egg, and the Poor Man's Friend; (2) of *Citrus Bigaradia*, the Seville; (3) of *Citrus nobilis*, the Canton Mandarin, the Scarlet Mandarin, the Japan, the Thorny Mandarin, and the Tangerine; (4) of *Citrus Japonica*, the Kumquat. Amongst other citraceous trees were the Shaddock (*Citrus decumana*); the Bengal Citron (*Citrus cedra*, Gallesio); the Sweet Lemon (*Citrus aumia*, Risso); the Lisbon Lemon (*Citrus Limonum*, Risso). No limes were met with. The orange grown with most success in the district seems to be the Selecta, a fruit which when properly constituted will fetch a higher price in the market than any other of the same dimensions. The Cluster orange also does well, and so does the Parramatta, but the latter is very liable to Red Scale, especially on the fruit. The Navel orange, with the present system of cultivation obtaining in the district, does not do well, and is found to be a shy bearer. In view, however, of the high reputation which this fruit has in the markets of Australia and America, it were worth while to protect its blossoms from the influence of the dry winds. Shelter is its especial desideratum, and those trees which are naturally protected, as at Mount Pleasant and Ballard's Camp, seem to do well. In other places the case is so far otherwise that the trees are being cut back and cleft-grafted with scions from the Mandarin. Of preserving-oranges the Poor Man's Friend is an exceedingly profitable one; the Seville is the one of all others which can withstand the effects of drought.

Lemons do remarkably well, and although the Lisbons have not such keeping qualities as the Sweet lemons, the fruit is much better grown and larger. Moreover the Sweet lemon is especially subject to the attacks of scale. Citrons, in Toowoomba, seem to be the attraction for all the enemies of citraceous trees—scale alone excepted,* but they fruit well. So do Shaddocks. The last two mentioned trees are little grown, their fruit hitherto having only to a limited extent been put to a profitable use. The above citrus plants are cultivated for their fruit only, no one having, as far as could be learnt, given attention to the production of citric acid (now in great measure manufactured synthetically from chemicals) or the numerous articles which perfumery derives from the leaves, flowers, and peel, especially of the Seville orange.

With reference to the situations in which most of the orange trees are grown, it may be stated that these are often the worst

* This statement probably requires to be reviewed and qualified. The Citron tree at Brisbane is often very subject to Scale Insects.—H.T.

possible, and do not supply the prime requisites for the successful cultivation of oranges, viz., shelter from dry westerly or other winds, and abundant natural surface and subsoil drainage. The Mount Pleasant orchard, that of Mr. Gregory, the Highfields road—one of Mr. Roessler's orangeries, and Ballard's camp are quite exceptional in this respect. In these both the above requirements are obtained, the trees being planted on the sheltered aspects of hill sides whose soil is both free and otherwise eminently suitable. Usually, however, "nice level sites" seem to have been selected; which have nothing naturally to recommend them, neither have artificial means of improving them been availed of to any great extent. Drains are conspicuous by their absence, so are break winds, and irrigation is unknown. When the orange trees are planted too shallowly, as they sometimes are—as in the garden of Mr. H. M. Nelson—their roots, which naturally come near to the surface, are either parched up throughout the day or chilled during the hours of nocturnal radiation. Those trees that are planted too deeply, as at Raceview, when a drought is not prevailing, seek their sustenance in a soil soured with stagnant moisture, and during the summer months, being exposed to the dry hot winds which are then so often prevalent, and fierce morning sun, exhibit the phenomena of trees having the parts above the surface thoroughly heated through, whilst those beneath, surrounded by a medium many degress lower in temperature than is the air to which they themselves have no access, are quite reversely conditioned.

When the trees are shallowly planted the practice, not uncommon in the district, of mulching them with old culms of maize is no doubt highly beneficial, but this procedure when deep planting has been adopted, only, perhaps, aggravates the ill effects for which the latter is responsible. Further, when mulching is resorted to, it is not an uncommon thing to find the material used heaped round the stem of the tree, and decomposing in that situation, and so doing more harm than good. The fact being perhaps recognised of orange trees naturally drawing their sustenance from near the surface, many cultivators in the Toowoomba district who do not mulch their trees, suffer the soil surrounding them to be as little disturbed as possible, and so allow it to become close and hard rather than cultivate it slightly, and thereby render it free and aerated. In more than one instance we noticed neighbouring trees whose branches overlapped. These of course had been planted too closely together. This dense planting, to use the words of Dr. G. Bennett, "is an important error, as there is not a tree that exhausts the soil more rapidly than the orange, and destroys one another. It has been remarked to me 'that the greatest enemy to the orange tree is its own kind,' that is, when they are planted too close together."*

The practice of manuring orange trees is not very common at Toowoomba. Without a series of analyses of the soil and a comparison of its constituency, as thus displayed, with the known composition of the orange, it were hazardous to indicate the adoption of any particular fertilizing agent. But that it requires some, in long cultivated soils, seems more than probable. Even the riches of the Toowoomba soil are not inexhaustible, and the orange, as above remarked, needs a

* "On the Introduction, Cultivation, and Economic Uses of the Orange, and others of the Citron Tribe, in New South Wales." Sydney, 1871, p. 14.

pretty large supply of them. This is so important a consideration that the following quotation relating to the subject may be admitted here: "There is a circumstance that deserves to be borne in mind by orange growers, and this is the absolute amount of material annually carried away from the land in the produce of the tree, and never returned again except by those who manure. Let any one compute what this is. Mr. Watt has obliged us with the result of a practical analysis thus made. The average weight of an orange he determines to be 4 ounces, so that one dozen of them may be said to weigh 3 lbs., and 250 dozen (no unusual product for a good-sized tree) 6¾ cwt. Directing his attention only to the peel, he discovered that the peel of an orange weighing 4 ounces weighed 960 grains. When the peel was burnt the ash weighed 7 grains. Computing this abstraction on the supposition of the crop above named, it will be seen that each tree will remove of absolute soil or soil elements, which must in some way be restored, 2½ lbs., and taking seventy trees to the acre, nearly 2 cwt. per acre. Now be it observed that of this bulk fully one-half is potash in one of its compound forms. The other half consists of silica, lime, and phosphate of lime, &c. Potash is not supplied to the soil either by the water or the atmosphere. Some soils contain absolutely no potash. It does not, however, follow that these soils will not produce plants requiring potash, because it may be artificially supplied."* Authorities examined by Mr. G. E. Alderton have shown him that "orange trees before they reach the bearing, require nitrogenous manure, and, after they have begun to bear, alkalies." "The chief chemical component of the orange tree is lime, hence the tree requires it as food.† On the other hand, orange trees may be too highly manured, and this is a frequent cause of disease. Also, manuring them will not accomplish much when other conditions for ensuring a prolific and good crop fail. As an instance, Mr. Roessler showed us a cultivation where the ground was nearly level and naturally exposed, and where, though the soil had been well trenched and enriched with "hundreds of loads of stable manure," the trees bore indifferent crops and were subject to scale and other diseases. Both potash and lime also in excess are probably prejudicial. Messrs. T. E. Thorpe and H. Knopf, in the "Journal of the Chemical Society," commenting on chemical analyses which they therein describe, of different parts of orange trees, (1) suffering from a well known and fatal disease, "lagrima," and (2) of perfectly healthy trees, remark:—"It will be noticed on instituting the comparison (between the two sets of analyses), that the composition of the ashes of the healthy tree differs widely from that of the diseased specimens. The want of analogy is more particularly seen in the undue proportion of lime and the comparative lack of phosphoric acid in all parts of the unhealthy tree, with the exception of the fruit; but the concentration of potash in the latter is remarkable. Whether, however, these deviations may in any way be connected with the *source* of the disease, or are themselves its results, remains to be proved."‡

We have dwelt to this extent on the cultivation of the orange at Toowoomba because, as we observed, much of the disease—especially

* Quoted by Dr. G. Bennett from "Journal of the Horticultural Society of New South Wales." *Op. cit.*, pp. 28-9.

† "Treatise and Handbook of Orange Culture in Auckland, New Zealand." By Authority: Wellington, 1884, p. 23.

‡ "Journal Chemical Society," 1868, pp. 523-4.

constitutional disease—to which it is subject to there, is attributable to errors of cultivation and neglect, rather than to the fact, readily put forward if so, that the trees affected are worked rather than seedling trees ; and if worked, grafted on lemon rather than on orange stocks. Healthy orange trees may be infected by insect or fungus pests equally with unhealthy ones ; but in their case the vegetative processes are powerful enough to enable the tree to hold its own their presence notwithstanding.

In some part of the district oranges feel the effect of frost. Mr. Roessler stated that at his Gowrie Creek estate the climate had proved too cold for this fruit. Some of the oranges growing there were, in the winter of 1885, completely cut down by frost, and those in the upper part of the ground were so badly affected that they escaped only after their upper branches had been cut back. The orange trees in this orchard were now found to be wonderfully free from disease, though, as might be expected, they had not yet recovered their full-bearing capabilities. It should, however, be borne in mind that it is not so much the frost which injures the trees, as does the sudden change of temperature to which they are subjected when the morning sun shines upon them. They should, therefore, in all cases be protected from its influence by means of shade trees. Mr. G. E. Alderton has enlarged on this subject.* He quotes James Pye, of Parramatta, to the effect that "the morning sun does more harm than anything else," and Justice A. T. Holroyd, who remarked on the immunity which his trees experienced when subject to frost:—"This year, though we have had the hardest frosts I have known in the district, I have not seen in my orchard (*i.e.*—at Sherwood Scrubs, near Parramatta) a single leaf or shoot affected by the frost." It is a well-ascertained fact, too, that in other orange-growing countries frost is not an obstacle to the highly successful cultivation of the orange when other favouring conditions obtain. Many instances of the severe treatment afforded by the late drought were remarked, and we could not but notice how well the Seville orange had maintained its character of being able to thrive in a dry climate.

Propagation.—Our opinion has been frequently sought as to the merits of seedling trees on their own bottoms, and worked trees respectively. Mr. James Pye, of Parramatta, recommends the former, since seedlings make larger trees and bear more heavily,† are less subject to disease than worked trees. On the other hand, they take longer coming into bearing. He remarks, "Seedlings rarely bear at six years old and may be twenty before they do so." It must be borne in mind, too, that the seedlings of plants whose desirable characteristics have been obtained by cultivation do not invariably inherit the qualities of their parents. A practical agriculturist, Mr. George Neilson, curator of the Royal Horticultural Society's Gardens, Melbourne, has remarked, "We might sow a hundred (orange) pips and not get one (orange) that was worth cultivating, and you might have fifty out of the hundred that would be worth cultivating. It is a mere

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* "Orange Culture," pp. 24-25.

† Mr. E. A. McIntosh, of Lane Cove, Sydney, after much practical experience is, however, of the opinion that "the orange trees when grown from seed . . . . seldom bear such heavy crops as the worked tree."

chance.* But then in raising seedlings Mr. Neilson recommends sowing a case of rotten oranges just as they are (*L.c.*). To ensure a more definite result, however, we must resort to artificial selection. The great advocate of seedling trees, whom we have just quoted, viz., Mr. James Pye, thus describes such selection, " For all seeds used by me for raising trees or stocks I select the large, round, and plump seed; the lean and thin ones I throw away."† We are aware that there exists some method, the main feature in which is abundant root pruning, by which the earlier proliferation of seedling trees is obtained, but have no practical experience of it; neither are we assured by those who have advocated it that desirable properties which seedlings possess are not sacrificed in obtaining such a result.

In a publication issuing from the Government Printing Office we are informed that " The lemon stock cannot for one moment be countenanced as a satisfactory one for the orange tree" ; "It is not in my power to point out a single orangery in this colony, large or small, where the trees are growing, and to say that they are doing well,"‡ and again, " Beware of purchasing orange trees worked on the lemon stock, for they are a failure everywhere in Queensland, and the direct cause of most of the failures with which our orange growers are troubled. Orange trees worked on the lemon stock are dear at a gift."§ The accuracy of this statement is, however, opposed to the fact that at the National Association's Show held in Brisbane, in 1886, the highest award for oranges was given to a collection derived from trees grown on lemon stocks, and that this collection was not limited to one or two kinds only, but comprised no less than thirty-eight recognised varieties.

The opinion, however, of many orange growers in the Toowoomba district, from one of the orchards of which this collection was derived, is opposed to the use of the lemon stocks. They seemed to have traced a connection between the existence of trees worked on lemon stocks and the occurrence of orange tree diseases; this is especially so in the case of a malady pretty generally recognised as "foot rot." And so rooted are they in this opinion that even when there is reason to think otherwise they infer that a tree must have been originally grafted on a lemon stock, for the simple reason that it is now affected by this disease. On our part, however, from an extensive general inspection of orange orchards in Toowoomba and other districts, we have not found any such connection. When the ill effects due to unsuitable situation and soil, to improper cultivation, and to neglect, have been eliminated it will not be found that lemon stocks have such an evil reputation, but that trees on orange stocks are equally liable to disease. Mr. Roessler drew our attention to a case in point, where orange trees worked on orange stocks and growing in an unfavourable site were, several of them, affected by " foot rot," one indeed being the third planted at one station which had succumbed to this disease.

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* " Royal Commission on Vegetable Products," Victoria, 1886. Third progress report and minutes of evidence, p. 118. By Authority: Melbourne.

† Quoted by Dr. G. Bennett, " On the Introduction, &c., of the Orange in New South Wales," p. 15.

‡ " The Queensland Horticulturist and Gardener's Guide." By T. Wright, Brisbane, 1886, p. 32.

§ Op., cit. p. 119.

Seedling trees, too, are so affected, as we especially find when we study the descriptions of orange growing in other countries.

Those who advocate the use of lemon stock for the orange, and there are many of this opinion in New South Wales, state that it produces a vigorous grower, makes a tree sooner, and gives the quickest return,—that a good grafted lemon stock will grow into a tree twice as fast as a grafted orange, and produce soon and heavily. On the other hand, trees so raised do not attain the longevity which is reached by unworked seedlings or oranges grafted on their own stocks. But it must be always understood that woods which are brought together in a graft must be well matched, and that there generally must be some constitutional similarity between them. If we wish to propagate the Kumquat we do not resort to an ordinary orange for a stock, but must perforce utilize the Citrus trifoliata *(Linn.)*; and in the same way the lemon stock will be best adapted for propagating trees of its own kind—*i.e.* lemon trees—whilst at the same time also it is suitable for strong vigorous-growing oranges such as the Parramatta, and unsuitable for such as the Mandarin. The constitutional affinity between a particular orange and the lemon may be closer than that existing between one orange and another. On the other hand, there are cases in which we do not require this constitutional similarity to be very close. For instance, when we look to the influence of a stock which is suitable for a particular climate to be exerted in the direction of rendering the growth in the same climate possible, and moreover profitable, of a large number of its allies—or even a single one—naturally growing, or artificially raised, under different meteorological conditions.

The question arises, what stock, then, is best suitable for the Toowoomba climate? We should say unhesitatingly, the bitter orange or Seville, on account of its drought-resisting properties. This stock, however, cannot be used in all cases, in some of which a sweet orange stock is indicated, in others a Lisbon lemon. Again, in other cases there is no doubt that good results would be derived from the use of one or other of our native citraceous trees as stocks; and we are glad of an opportunity of pointing to the only attempts that, as far as we can learn, have ever been made in this direction, or even suggested, although it would seem *à priori* probable, from the results accomplished by the aid of native stocks in the case of other economic plants, that benefit from the use of native orange stocks would accrue to those employing them also. Mr. Hitchcock has experimented with the native lime of the Toowoomba scrubs (Citrus australis, *var.* Planchoni *F. v. Mueller)*, which is described as "A noble tree, fully 40 feet high, or, according to Hartmann, even 60 feet high, with globular fruits about the size of a walnut (often much larger—H. T.), called in Australia, Native Oranges."* In one case Mr. Hitchcock raised three or four dozen trees on seedling stocks of this tree. Some of these we examined and found that though they were not so large as the majority of the other orange trees grown on ordinary orange seedling stocks (which in Mr. Hitchcock's orchard are unusually well developed), they bore fairly well and were quite free from disease, although a very little Red Scale (*Aspidiotus coccineus)* was

* Ferd. Von Mueller in "Select Extra-tropical Plants." New South Wales edition (enlarged), Sydney, 1881, p. 83.

present on them. (2) In the case of a Japanese Mandarin on the native citrus, a tree was shown us which had been twelve years planted out. It had reached a height of 12 feet (rather more than less), was well formed, perfectly healthy, and bearing well. It was stated that had the scion of the mandarin been grafted on a Seville stock, the tree would have been four feet higher, but that the fruit would have been no better. These interesting experiments might be profitably repeated in other orchards and districts. It would be interesting to find out whether the small "native lime," *Atalantia glauca*, which grows in very dry districts, and not far to the west of Toowoomba, would, or would not, be serviceable as affording stocks for the propagation of citraceous trees. It might, we think, do in the case of the Kumquat. We have placed a number of seedling plants under the care of the experienced horticulturist, Mr. B. Crow, of Toowoomba, and trust that when they reach their destination, Mr. Hitchcock's orangery, the experience of the latter in orange growing in many parts of the world will be able to turn them to some good account.

The following are the principal diseases to which the orange is subject at Toowoomba :—

Insect Pests.—Fruit Fly (two kinds), Orange Moths, Leaf-eating Caterpillars (three kinds), Borers, Scale Insects (seven kinds), Root-eaters, Aphides, Green Bug, Black Bug, Locusts, Grasshoppers, Acari (Maori oranges). *Fungi* :—Leaf Fungi (black spot, scab), Foot-rot, and the epiphyte, Cassytha.

We have included a description of others also, some of which are only sparingly felt at Toowoomba, and the remaining ones not at all. These last, however, as is probable, will, we think, arrive in the district sooner or later.

MULBERRY.

Nearly every garden in Toowoomba contains one or more trees of the mulberry, and this fruit succeeds well in the district, and ripens from October to November. Sericulture seems to be quite unrepresented even amongst the minor industries of the district. The chief pest of the mulberry is a small nitidularian beetle, a species of Brachypeplus, which, immediately upon the fruit becoming ripe, insinuates itself amongst its component drupes, imbibes their juice and thus destroys them. Each fruit is attacked usually by several of these diminutive beetles. At Paradise estate it was observed that the foliage and young shoots were infested by a leaf-eating caterpillar. In the vicinity of Brisbane the mulberry is often attacked by the scale *Lecanium oleæ*, and when this is the case one or other of the black coloured fungi which help to constitute the sooty matter which we deal with under the designation *fumagine*, also accompany it to the further detriment of the tree. This pest has not yet been observed on this or other fruit trees at Toowoomba. At Brisbane, again, the mulberry is often infested by the Red Orange Scale.

WALNUTS.

A few Walnut trees were noticed in the district, and especially in the neighbourhood of the Ranges—from Highfields to Mount Pleasant. Both young and older trees seemed to do well, as far as

could be judged prior to the fruit being mature. At this stage, however, the green husk often displays black spots or patches, or even a considerable portion of it may partake of this colour, and be also somewhat shrunken. Examination of the Walnuts which display these appearances will usually show that the kernels have been retarded in their progress to maturity. Oftentimes there is no indication on a tree of this affection; sometimes two or three fruits only are subject to it, and less frequently still quite two-thirds of the crop are damaged. The injury which this blackness betokens is caused by the attacks of a fly, very different, however, in appearance—as can be reasonably inferred—from the ordinary Fruit Fly, but one which, as far as the Walnut is concerned, has similar habits. Only the maggot stage of this insect has been observed by us.

Remedies.—Only preventive measures are available in contending with this pest, and must be generally such as are used in the case of the ordinary Fruit Fly.

SPANISH CHESTNUT.

Wherever the growth of this tree has been attempted it seems to do well. In confirmation of this statement, it may be observed that Mr. Hanley, of the "Paradise" estate, has several Chestnut trees growing. They were planted as suckers sixteen years since, and are now fine trees. Most of them have simple trunks. One of these had a circumference of 3 feet 9 inches at a distance of 2 feet from the ground. Another, which had been permitted to fork at about 1 foot from the ground, had a circumference of 7 feet below the fork. All these trees were prolific bearers. No insect pests were noticed or commented upon as injuriously affecting them.

In addition to these there are the *Fig*, *Guava* (including Pisidium), *Passion Fruit*, *Persimmon*, and *Vine*, amongst fruits.; numerous vegetables, the most important being *Cabbage*, *Potato*, *Sweet Potato*, *Pumpkin*; Cereals, *Wheat*, *Maize*, &c. Artificial Fodders, including *Lucerne*.

It would unduly prolong this Report to consider these with that attention to details which their treatment merits, and therefore they are now passed by without further notice.

CHAPTER II.

Diseases of Fruit Trees—Pip Fruits.

APPLE.

Woolly Aphis (*Schizoneura lanigera*, Hausmann).

During our visit this pest, which is otherwise known as the American Blight, came but little under notice; a circumstance probably due to the fact that it was not specially sought for, rather than because it was generally absent.

The Woolly Aphis must have been a terrible scourge of the apple trees of Toowoomba in former years. Mr. J. B. Robinson stated, in evidence of this, that he had lost two hundred apple trees through

its attacks; Mr. Hanley, of Paradise, Drayton, that sixty of his apple trees had been destroyed by this insect. It is not, however, quickly fatal. Mr. Hertzer, of the Middle Ridge, pointed out a solitary tree and informed us that it alone survived of several others which had been planted out with it, some twenty- one years since. This single tree was now covered above ground with the blight, even to the tips of its branches, and yet bore abundant fruit. Similarly a tree was seen on the estate of Mr. M. Stenner which had had American Blight, as was stated, for twenty years, and yet was covered at the time of our visit (7th February) with fruit.

The apparent comparative immunity from the attacks of Woolly Aphis which the apple trees of the district exhibit is largely due to the fact that the so-called blight-proof varieties are now almost universally used, at least as stocks. The most popular of these varieties are the Irish Peach, the Northern Spy, and the Winter Majentin.* Other reputed blight-resisting apples do not appear always to remain immune at Toowoomba. The Summer Pearmain and Stephenson's Winter were pointed out by Mr. H. Hopkins, gardener, as a proof of this assertion—they being, as was observed, blight-stricken varieties.

This disease is so generally known amongst fruit growers that it is scarcely necessary to enter into minuteness of detail regarding it.

Appearances due to Disease.—When but a few insects are present they give rise to a white cottony film at the bottom of the crevice where they occur. When they have already become numerous the spot appears as if a knot of cotton wool was stuck to it, and as they still further increase they may form cottony dependent pieces. By inserting their rostra or beaks into the bark the insects imbibe the sap of the tree, which, in response to the irritation which this injury occasions, gradually develops the well-known knotty appearances. Not only does the Aphis establish itself anywhere on the trunk, branches, or branchlets, especially where either of these have been injured; but also on the roots, on which it causes, too, the characteristic excrescences.

The Insect and its Life-history.—In spring time these woolly masses consist of young reddish-brown aphides (or larvæ), those which have already developed into full grown aphides of a darker colour, and the representatives of intermediate stages of growth. The quite young insects are without threads of wool-like secretion, but during development, emit spiral filaments from dorsal pores to such an extent that the whole body finally becomes densely lanigerous. All these insects are without wings, and are potentially females, capable of a-sexual reproduction. These wingless aphides, when adult, viviparously produce young like themselves, which, in their turn, are similarly reproductive. Towards the end of summer, after many generations of aphides have thus arisen, most of these wingless viviparous females produce winged female insects which are still

* In the experimental grounds in the gardens of the Royal Horticultural Society, Melbourne, Victoria, the following additional varieties have continued to be proof against the attacks of the American Blight:—Tetofsky, Stubbart Codlin, Striped Beaufin, Ruby Pearmain, New England Pigeon, Magg's Seedling, Lord Wolseley, Golden Queen, Fall Beauty, Early Richmond, Chastatee, Autumn Tart, American Golden Pippin, Primate, Menagerie, Yarra Bank.

viviparous, and these in their turn give birth to wingless oviparous females, and also small winged male insects. These last classes produce eggs, a single egg being laid by each female aphid. In addition to the eggs which hatch when the next spring ensues, there are nmbers of wingless viviparous females which are the progeny of aphides which have not given birth to winged viviparous females, and so on. These hibernate during the winter months, and when the latter are past, also assist in continuing the race. The winged viviparous females are of a shining dark-brown colour, are pitchy or green between the wings, or with the abdomen chocolate brown; their wings have the third branch vein with a single fork.

Treatment.—1. We are indebted to the "Gardener's Chronicle" for June 19, 1886 (vol. xxv. pp. 794-5), for the following recommendation as to treatment:—

Young trees.—When young trees first become affected a number of remedies may be effectively used. Rubbing or brushing kerosene in the infested spots, washing them with "lye" (¾ lb. to the gallon of water); strong solution of whale-oil soap; or sulpho-carbonate of potash, will arrest the disease.

Roots.—When the roots of large trees are thoroughly infested, it is said that there is no remedy so inexpensive and at the same time efficacious as Gas Lime—the refuse of gas works. This should be employed in the following manner. Spread about one shovelful, or more according to the size of the tree, in a dry state within a radius of four feet over the surface. The Gas Lime being a caustic substance should not be placed immediately around the trunk, especially if the trees under treatment are young, and to kill the aphides that may therefore remain at the root-crown, and also to prevent others from working downwards from above, fresh ashes are to be piled in this situation. In England it is the custom to trust the rain to wash the lime into the soil. When applied to a given spot it is said to retain its effectiveness for three years, but its powers are doubtless diminished if it is exposed to air and rain.

2. Professor Kirk, evidently referring to the treatment of those parts of the tree which are above ground, states that in New Zealand he has never known the following application to fail, when properly applied—this is castor-oil containing 2 oz. of wood-soot to the gallon. He also informs us that the Minister of Lands, New Zealand, has officially recommended the following effectual method of treatment in dealing with the occurrence of the woolly aphis on the roots:—

"Four pounds of sublimed sulphur in an iron-pot, with enough water to stir conveniently while boiling for twenty minutes; then add 1 lb. of caustic potash (Greenbank Company's is the best), previously dissolved, and whilst still hot, and as much colza or other vegetable oil as will make it like a thick paint. Then, when warm, with a large paint-brush, daub it for about the space of a foot round the butt of the stem of the tree. Rain will wash it into the roots, and the oil will tend to preserve its strength for years."

3. Resin Compound.—Mr. A. Koebele states that he has always had success in destroying the woolly aphis when it occurs, both above ground and on the roots of apple trees, by use of this compound. For work above ground he sprays a fluid containing one part of the com-

pound to eight of water; but he appears to recommend a stronger solution, viz., 1 to 6, for contending with the pest when it affects the roots.* *See* note under "Mussel Scale," p. 40.

THE MUSSEL SCALE (*Mytilaspis Pomorum*, Bouché).

This insect, which in other countries deleteriously affects not only the apple but also the pear, plum, and several ornamental trees and shrubs, has not, as far as we are aware, been established anywhere in the colony. It may, however, be frequently noticed on imported apples, to which it adheres with some pertinacity; and on them it is conveyed from one end of the colony to the other. There is every probability, therefore, of its becoming naturalised here; and so an additional pest to the fruit grower.

The Mussel Scale is said to be a native of Europe, and to have been described by Reaumur as early as 1738, and subsequently by Gmelin. W. C. Whitehead, Entomologist to the Agricultural Department of the Privy Council, states that in England "Apples and pear trees with smooth bark suffer more from this scale than those with thick rough covering." There are several kinds of apples there that "are especially liable to receive injuries from this insect. Young trees have been killed outright."†

From England this pest was introduced on apple to the United States, and in 1870 was regarded as being "on the whole the most pernicious and destructive of any insect in that country." There its life history has been investigated by Harris, Professor Riley, Dr. Shiner, Comstock, and many others.

It has also found its way to New Zealand. In 1886 Professor Kirk reported, "At the present time this pest is causing serious loss in the Western and Canterbury districts, where, in certain localities, it has led to a diminution in the annual yield."‡

The Mussel Scale occurs, too, in Tasmania, where "it is spreading rapidly and is not particular what it attacks, even to black currants and gooseberry bushes."§
When it infects a tree it occurs in such profusion that the branches and branchlets are literally covered with it.

Description.—Adult Female.—Scale.—Elongated, narrow, widened posteriorly or mussel-shaped more or less curved, of ashy-grey or brown colour. Discarded pellicles or exuviæ at one end of scale, yellowish. Scale open underneath adhering by its edges to the tree. Length averaging $\frac{1}{10}$ inch, breadth nearly $\frac{1}{30}$ inch. *Animal.*—Elongate-oval, cephalic end and about half the rest smooth, the remainder much corrugated. Legs and antennæ absent; three or four spines on some of the corrugations near the abdomen. Abdominal border regularly curved having triangular and foliated lobes; the two central lobes the largest, with a smaller lobe on each side of them; strong spines

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* *Vid.* Report, Department of Agriculture, United States of America, 1886. Report of Entomologist, p. 147. Washington, 1887.

† Report on Insects Injurious to Fruit Crops," p. 104—London, 1886. See also "Agricola" (Curtis) in *Gardener's Chronicle*," London, 1843, pp. 735-6.

‡ "Report on Fruit Blights and Diseases of Fruit Trees." Reprint, Brisbane, 1886, p. 16.

§ Mr. Howard Wright, *vide* Frazer S. Crawford in "Report on Fusicladium, &c.," p. 51. Adelaide, 1886.

between the lobes. Five groups of spinnerets around the anal opening; of which the upper and each of the superior lateral contain seventeen, and the inferior lateral groups fourteen spinnerets.

Male.—Scale.—"Much smaller, with a single moulted skin, and with the posterior part joined to the remainder of the scale by a thin portion which serves as a hinge."—*Comstock.*

Eggs.—These "are . . . . oval in shape, of a white or opalescent colour, changing to yellow as spring comes on."—*Maskell.*

Life History.—"When in the perfect state the female insect occupies nearly the whole of the puparium or scale. Later on, however, it begins laying its eggs with which it gradually fills the shield, shrivelling itself into the narrow end of it . . . . . . The eggs are usually from thirty to fifty in number (but they may be as many as one hundred.—*Packard*) under each scale."—*Maskell.* The eggs are hatched when still under the scale, and soon after this event the young occur as yellow specs amongst the mother scales. The young insect is provided with antennæ, and having properly constituted legs, moves freely about. It then fixes upon a suitable resting place, and transforms by casting off its first pellicle—which remains where dejected to form part of the puparium. The antennæ and legs at this time disappear. The insect now begins to spin the shield proper or broader portion of the scale.||
Professor Riley has found from observations made in Illinois that about fifty-five days occur from the time the eggs are hatched until the insect is fully developed; and that the eggs commence to be layed about ten days or a fortnight after this event.

Natural Enemies.—Dr. Shiner has noticed in America an Acarus parasitic upon the Mussel Scale, and Mr. Maskell has observed Acari also, moving suspiciously amongst the eggs of Mytilaspis, in New Zealand.

Remedies.—Preventive: Avoid bringing imported apples into the fruit-growing districts. Apple-peel, or the core of the apple with the "eye" still attached, may contain the female scale. The young on hatching may for a time find sustenance, and also increase and multiply upon quite a number of plants (Mr. Maskell mentions in this connection "plum, peach, apricot, pear, lilac, cotoneaster, thorn, sycamore, ash, and many others"), until an opportunity occurs for its being transferred to the apple, and there developing its peculiar destructive energy. Curative: See under "Peach Scales," p. 91.

NOTE.—For this and other scale insects the following *Resin Compound*, which has given very satisfactory results when experimented with in California by Mr. Albert Koebele, as agent for the United States Entomologist, might be profitably tried. This is prepared as follows:—Dissolve 3lb. of sal-soda and 4lb. of resin in 3 pints of water over fire; when properly dissolved, add water slowly while boiling to make 36 pints. One part of the compound to 4 of water, or a mixture no stronger than such as contains 3 parts of the compound to 8 parts of water, would in all probability be found to be effective as a fluid for use with the spray.

Dr. J. Bancroft has for some considerable time been in the habit of removing scale insects, forming similar incrustations on the bark of

|| *Vid.* W. M. Maskell: "On some Coccidæ of New Zealand." *Trans. N.Z. Inst.*, 1878, vol. xi., pp. 192-194; pl. v., fig. 2 a, b, c, d.

trees at Brisbane, by means of a fine wire brush. It seems necessary however, that some means should exist for the destruction of scales removed, otherwise this process might aid in their dissemination.

Wood-Boring Caterpillar.

Caterpillars, measuring less than an inch in length, and which, owing to the presence of small coloured blotches on the surface, had a pinkish red hue, were noticed injuring some of the Toowoomba apple trees.

Symptoms.—Where pruning had taken place small borings lead into the part in which the dead and living wood unites. The presence of such injuries was usually indicated by the occurrence of small particles of rejected food material at the entrances to the burrows.

The Caterpillar.—The caterpillar is cylindrical, smooth, with a few scattered white hairs, three pair of thoracic legs and four pair of abdominal prolegs. General colour white with pinkish red blotches—those along the centre of the back forming a longtitudinal broken double band, and black hair bearing spots. Head brown ; neck white ; first thoracic segment very dark brown with an interruptedly white anterior border and two blotches, one on either side of the middle line, of the same colour. Second and third thoracic segments with three black spots on either side, a dorsal one, a lateral one immediately below this, and an inferior lateral one below the latter. Succeeding segments with two dorsal spots—one anterior and one posterior, one lateral ocellated spot, and one inferior lateral, and a spot posterior to and a little above the origin of each limb. Abdominal limbs with an arcuated spot on outer aspect of first joint. Those segments without appendages having each a transverse series of four marks on the under surface, the central pair being the smallest. Terminal joint of palpi, thoracic limbs, and claws of abdominal prolegs light brown. Length 14 mm. $\frac{13}{16}$ inch.

The Chrysalis.—Not observed.

The Moth.—Not observed, but probably a member of the Fam. *Tortricidæ*, and of small size.

Leaf-Eating Caterpillar (*Orgyia postica*).

This pest was not observed at Toowoomba, although it is probable that it is sometimes noticed there. Attention was first called to the destructive habits of *Orgyia*, in the caterpillar phase, by Mr. H. Hockings, on 18th April. He then brought some very young examples, which he had found feeding on apple trees at Woolloongabba. In this case the caterpillars had eaten holes into the substance of the leaves, and had gnawed portions of their edges, but generally seemed to avoid the denser tissue of the veins. The effect on apple trees of the presence of this insect is thus very evident, and such is its voracity that a few caterpillars only are able to quite check the growth of young plants, which accordingly die.

It is evident, on examination of the figure, given by F. Moore* to represent the caterpillar of Orgyia postica (*Walker*), and on perusal of the description given by this authority to characterise the

* "The Lepidoptera of Ceylon," Pt. vii., Pl. 109, 1 b.

same insect, that we have to deal with a phase in the life history of this well-known moth to which the following characters apply:—

The Caterpillars.—These are readily distinguished. They are of a yellowish colour, "with a dorsal and two lateral purple brown bands; head red; two long tufts of purple brown hairs, individually of different length, project over the head and two over the anal or terminal segment; two lateral tufts of whitish hairs extend laterally from the fifth and sixth segments, and a dorsal brush of short yellow hairs crowns the fifth, sixth, seventh, and eighth segments" (*Moore*). They attain a length of $1\frac{1}{4}$ inch., and are very active in their movements.

The Chrysalides are hairy, $\frac{1}{2}$ inch or more in length and end in a fine point. They are contained in a very light-coloured thin cocoon, on the surface of which are inwoven the long hairs of the body of the caterpillar.

Imago.—The sexes in the perfect insect are very different. The *female* is of a very light, greyish-brown colour. It has a thick cylindrical body, and its wings are quite rudimentary, and appear to be almost wanting. The *male* has a slenderer body, and is furnished with the full complement of wings which expand to nearly one inch. The anterior pair of these are of a rufous brown colour, are crossed with fine zigzag (often ill-defined) black lines, and are irregularly marked with brown blotches. The hindwings are of a uniform smoky brown. The antennæ are on each side, broadly comb-like.

Natural Enemies.—It is highly probable that this caterpillar is untouched by insectivorous birds, and that these are warned that it contains something which is unpleasant to their sense of taste or smell, by the exhibition of conspicuous characters, even if the hairs themselves are not irritating, and so distasteful. The closely allied insect—*Orgyia antiqua*—when in the caterpillar stage, has similarly conspicuous colours, tufts, and eversible dorsal glands, and has been experimentally demonstrated by J. Jenner Weir* to be "disregarded by all the birds." The immunity, however, which this caterpillar may be reasonably expected to possess from the attacks of insectivorous birds is probably lost when the chrysalis stage is arrived at; for in America it is recorded by Dr. Brewer of another congener—*Orgyia leucostigma*—that in a particular district its caterpillar was very destructive for two seasons, until the pest was almost extirpated by sparrows which were noticed engaged in the destruction of the cocoons.† When, however, the insect reaches the next stage, it, or the female at least, is quite free from the attacks of insectivorous birds. And yet it seems so helpless. E. B. Poulton writes concerning the female imago of *Orgyia antiqua*, and his remark applies to the Queensland Orgyia—"The female Moth has rudimentary wings, and never quits its cocoon, but sits on the outside of it, being very inconspicuous, as it is covered with grey down, which harmonises well with the colour of the surface upon which it is resting "‡—and again, "It would be impossible to find a more helpless insect, without even the power of attempting to escape by walking,"§—and yet, as he adds, quoting J. Jenner Weir, "'It is the only lepidopterous insect

* Proceedings of the Zool. Society of London, 1887, p. 200.
† *Vid.* Proc. Boston Soc., Nat. Hist., vol. xix., p. 260, 5 Dec., 1877.
‡ Proc. Zool. Soc. London, 1887, p. 248.
§ *Op. cit.*, p. 264.

entirely rejected in the perfect state.' Disregarded by all the birds (experimented with) except (the) Robin and Reed Bunting, and refused by these after examination" (p. 249). The eggs are deposited in a sticky and frothy substance, and this hardens on exposure; they, too, are therefore protected from the attacks of birds if not from those also of other enemies.

Distribution, &c.—Within the colony the range of this insect is not known. The caterpillars are often to be observed feeding on the leaves of different species of Albizzia, but they also occur on plants of a quite different order, and may be especially destructive to the foliage of the rose. Mr. F. Moore records the observation of Thwaites: that Cæsalpinia is one of their food plants.

Remedies.—The caterpillars, the cocoons, and the female moths are all conspicuous objects, and may be removed by hand picking.

Codlin Moth (*Carpocapsa pomonella,* Linn).*

The Codlin Moth is so notorious a fruit pest that the occurrence of it in the caterpillar stage, as observed in Queensland—in Brisbane, at least—and the likelihood of its becoming established in the Toowoomba orchards, would seem to justify the insertion in this Report of the following remarks concerning it: Every effort should be made to observe it when it first appears, so as thus early to immediately, if possible, stamp it out. And as a preliminary to such effort on the part of fruit-growers, a description of the nature of the injury which the Codlin Moth occasions, as well as some account of its habits and appearance in the different stages of its growth, should be available to orchardists here, and some hints as to the direction in which these efforts are to be pursued should be forthcoming.

To omit all reference to its occurrence in countries other than the Australian colonies. The Codlin Moth was first observed in Tasmania about thirty years ago. In Victoria it is of more recent occurrence. "There is no doubt but that it was first brought to this district (*i.e.*, Ballarat) in apple cases from Tasmania. Leaving there in the worm or grub state, it passed, either in transit or in store, into the chrysalis, secreting itself in corners of the cases, and in this way was carried all over the district in empty cases."† It was first observed in the Auckland district of New Zealand about twelve years ago, and in the Nelson about eight (*T. Kirk*). Its presence was not identified in South Australia until Christmas, 1885, although it had probably been present for one or two seasons previous to this (*F. S. Crawford*). It has not been in Sydney until the present year (1887). Its occurrence, on imported fruit, in this colony has only recently been ascertained—this was in May, when specimens of the caterpillars were procured in a fruit-shop in Brisbane. Worm-eaten apples arrive here, too, in plenty from the United States during September and October. When the fruit is harvested whilst the grub which it contains is still only partly developed, or if cold weather has already supervened—in which event the larva may lie dormant—a con-

* Note.—Previous to this article being written there was, "in present accessible form, no complete account of the Codlin Moth." This statement, made in 1887, afforded justification to the United States Entomologist for the inclusion of an able article, by L. O. Howard, relating to this insect, in his Annual Report for that year, and the fact it alludes to our effort also to supply the omission.

† Ballarat Horticultural Society, in "Codlin Moth, Report of Secretary for Agriculture." Victoria, 1885, p. 9.

siderable time may elapse before even the chrysalis condition is reached and the insect be transported far from its birth place. Already, as in the United States also, its presence in Tasmania has been the occasion of special legislative action there; so also in New Zealand and in South Australia. The extent of the damage which it has occasioned in each of these countries is the subject of common information.

Symptoms of its presence.—The fruit changes colour, or ripens earlier than it otherwise would and usually falls to the ground. On examination of the fallen fruit this is found to have been bored by some insect, and to have a hole generally on one side of the fruit, or less commonly in the centre of the "eye." This orifice will vary in size according as the caterpillar has left the apple or not, and will frequently be observed to be filled up with dejected food material (frass), fastened together by fine threads. On cutting the apple in half, it will be observed that this hole marks the entrance to a passage, usually somewhat tortuous and of irregular breadth, which leads from the outside to the core. On examination of the latter it will often be noticed that the pips have been gnawn into and their contents extracted; also that the fruit has been excavated both above and below the core. All the burrowings thus formed will contain small black particles—pellets of excrementitious matter—and, as sometimes happens, in some part of them will be found the cause of all these appearances—a pinkish-coloured finely black-spotted grub, which on being disturbed will, suspended by a fine silken thread, drop from the apple or other fruit under examination. This is the caterpillar of the Codlin Moth.

Life History of Codlin Moth and its Mode of Attack.—"In early summer (September) when the young apple is just set, the moths, which have passed the winter either as larvæ (caterpillars) or pupæ (chrysalides) emerge from their confinement, pair, and within forty-eight hours the females (on some warm evening) fly from apple to apple, depositing an egg in (on) each until they have exhausted their stock." * The egg which is barely visible to the naked eye is either placed on the crown of the young fruit, within the eye, or if at an earlier date still, then on the summit of the ovary of the blossom—the tree being in flower. The egg is hatched in from seven to eight days. On examining a young apple shortly after this event a fine powder will be noticed in the centre of the eye, and the minute larva found in the upper part of the fruit at a small distance in from the eye, with its head directed towards the centre. Having reached the core of the apple, it either continues to feed on the pulp surrounding it, or extends its burrows to the side of the fruit, when having gained this it gnaws through the skin. The orifice thus formed is used as an outlet for the excrement of the caterpillar, for the ingress of air, and also for the emergence of the larvæ when fully grown. The chief mischief, however, is effected in the centre of the fruit. Ultimately the caterpillar seeks the pips which it gnaws into for the purpose of consuming their contents. This last is the action which determines the premature falling of the fruit. After this has happened the larvæ soon crawls out—this action on its part taking place about ten days or a fortnight after it has obtained its full size. "Its exit is rapid and many apples may be examined in the morning, which have fallen during the night,

* Report on the Fusicladiums, &c., by F. S. Crawford, Adelaide, 1886, p. 33.

before one is found in which a grub remains. The apples from which it has escaped may be recognised by the orifice of the hole being cleared." Should the apple, however, be one of those varieties whose hold on the tree is unusually firm, the caterpillar will leave it before it has fallen; in this case letting itself down from the fruit either on to the bough or to the ground by means of a silken thread of its own preparation. The caterpillar then crawls to the most convenient spot suitable either for its shelter in a dormant condition, or for safety after the almost immediate performance of its chrysalis metamorphosis. Such a spot is furnished by the trunk of the apple tree itself or that of some neighbouring tree, or by any dry wood, such as that of an old fence, or similar rubbish; the site immediately selected being a crevice in dead bark or within a dried clump of moss or lichen. This spot it shapes, by gnawing, to suit its requirements, forming a smooth cavity to contain the elongated oval cocoon of white silk, in which small fragments of debris are superficially woven. In this it now ensconces itself. Should the apple which has been thus attacked be an early one, further changes rapidly transpire, more than one brood being produced during the season. In the event, however, of the autumn having supervened, the Codlin Moth may remain during a great part of the ensuing winter in its larval state, but under most favourable conditions the chrysalis gives birth to the perfect insect—the moth, within a month.

Description of Codlin Moth in its different phases of life :—

" *The Caterpillar* when full-grown is of a dirty-white colour, with a brown head often with darker brown marks. The first segment of the body behind the head is whitish with minute brown spots, the remaining segments being whitish (or of a pink or flesh colour according to age), each with about eight very minute dark points emitting fine short hairs (these spots or points being so arranged as to make two rows down the back, and one on each side). Each of the three anterior segments is furnished with a pair of jointed legs, and each of the sixth, seventh, eighth, ninth, and terminal segments also bears a pair of fleshy tubercles or prolegs, with clasping hooklets. There is a dark line seen down the middle of the back of the larva, which is the alimentary canal within the body."—*I. O. Westwood.**

The young caterpillar is of a whitish colour. The following is its rate of growth, as given by authorities: When first hatched it is scarcely visible to the naked eye. When six days old it measures nearly a quarter of an inch, and is about as thick as a fine silk thread. In ten days it is about three-eighths of an inch long. In about twenty days, when it has attained its full size, it is from seven to nine lines in length.

The Chrysalis.—The chrysalis is of a bright mahogany colour, and measures five lines in length.

The Imago (*moth*).—"This," writes Westwood, "is one of the most beautiful of our small moths, measuring about three-quarters of an inch in the expansion of the fore-wings, which are ashy grey with darker marks, and with a large coppery or reddish golden patch at the hinder extremity, bearing smaller paler patches; the hind-wings are blackish." † Concerning it also, Westwood writes, in his "Insects at

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* "*The Gardener's Chronicle*," London, 1879, p. 649. The parenthetical marks are not contained in the passage to which reference is made.

† Westwood, *supra*, l. c.

Home" :—"This is a most exquisitely coloured insect. The upper wings are rich brown banded at the base and tip with darker and warmer brown. In the dark band at the tip of the wing is an oval mark of brilliant gold-coloured scales, having a very dark centre. In certain lights this dark centre takes a reddish hue ; even the outer wings, when viewed in a side light, shine as if made of the finest satin."*

These descriptions refer to the moth as it presents itself to European observers. As, however, it is desirable that every facility for recognising so formidable a pest, as is the Codlin Moth, should be given, no apology need be made for the introduction here of the following precise characterisation of Australian specimens of this insect, given in the language of E. Meyrick, a specialist in these matters. For a complete view of the Codlin Moth it is necessary to study this authority's definition of the genus Carpocapsa, in which it is included, in conjunction with his definition of C. Pomonella L., as a species of it.

Carpocapsa (*Tr.*) †—" Thorax smooth. Antennæ in male thickened, not ciliated. Palpi moderate, ascending appressed to face; second joint shortly rough-scaled beneath, terminal joint distinct. Posterior tibiæ loosely scaled. Fore-wings moderately broad; costa in male simple, slightly arched ; hind margin rather oblique, slightly sinuate. Hind-wings rounded, broader than fore-wings, in male with a short membranous ridge on lower median near base, and a grooved channel below it. Fore-wings, with veins seven and eight separate, seven running to hind margin. Hind-wings, with veins three and four stalked, five near parallel to four, six and seven separate.

"Allied to *Stigmonota*, but separated from it and other allied genera by the ridge and groove of the hind-wings in male. From *Epitymbia*, which has a somewhat similar structure, it differs by the separation of veins seven and eight of fore-wings, and the absence of a costal fold. The larvæ feed in fruit, and the genus is indigenous in Europe and North America; the only species found in Australia has been introduced together with the apple tree."‡

Carpocapsa pomonella, L.—" *Male and Female.*—7 $\frac{1}{2}''$-9″. Head, palpi, and thorax dark greyish fuscous, slightly sprinkled with whitish. Antennæ dark fuscous. Abdomen dark fuscous. Segmental margins whitish tinged ; legs whitish, anterior and middle tibiæ and all tarsi dark fuscous, with slender whitish rings. Fore-wings moderately broad, posteriorly dilated ; costa hardly arched ; hind margin oblique, indented beneath apex ; ashy-grey, with numerous irregular transverse greyish-fuscous lines, coalescing to form a rather narrow transverse band at one-third from base ; a moderately broad elongate ovate coppery fuscous patch on an anal angle, extending along hind margin nearly to apex, preceded and followed by a silvery metallic line, and containing two small silvery marks on anal angle ; the anterior silvery line is preceded by a blackish streak, extending

* A coloured representation of the insect in its European garb is to be found in Hübner's "Europaische Schmetterlinge" VII, Tortrices II, Noctuoides, c. fig. 30; and in its American, in "Report of the Entomologist," U. S. Agr. Depart., 1887, Pl. II.

† Carpocapsa belongs to the family Grapholithidæ of the section Tortricina.

‡ E. Meyrick, Proc. Lin. Soc., New South Wales ; vol. vi., p. 656. (Sydney, 1882).

from inner margin half-way across wing; cilia silvery grey, towards base silvery whitish, with a black basal line. Hind-wings fuscous grey; apex rather darker; cilia grey-whitish, with a dark fuscous line near base.—Described from Australian specimens." Taken from October to December.*

Preventive Measures.—All such must be framed with a due regard to the habits of the pest as previously detailed. They may be directed (1) towards preventing its after occurrence in the apple crop when this is still very young; or, what may be thwart with greater advantage, towards (2) securing the safety of the next season's crop.

At the time of apple blossoming, or shortly afterwards, the moth may be caught as it flits amongst the trees about sunset, an operation which may be best accomplished with the use of a gauze net, similar to that employed by entomologists for capturing insects. Moth traps, too, will, it is said, accomplish the same ends. At this time also it may, to some extent, be banished from the orchards by burning rubbish near the trees so as to create a smoke amongst them; or small bonfires may be lighted in the evening also, which should attract the Codlin Moths, and so destroy them before they have time to deposit their eggs. The Superintendent of the Botanical Gardens, Tasmania—F. Abbot—makes reference to the following remedy which may be adopted at this time. He writes, "A method commonly adopted in the spring or early summer months for destroying the moths is that of suspending lanterns in various parts of the garden with a view of destroying the moths. The lanterns should be smeared with some glutinous substance such as linseed oil, or have a saucer of the same suspended beneath them. In England and Wales, lanterns for this purpose are often constructed by tying a few willow or other twigs with a frame resembling in shape a Chinese lantern, placing a piece of clay in the angle of the willows, just above the bottom ties, in which to stick a piece of candle; the frame is then surrounded by a sheet of cartridge paper, which is kept smeared with oil during the season the lanterns are in use. The moths, attracted by the glare, become immersed in the oil, and are thus destroyed."† A. J. Cook, of the Agricultural College, Michigan, has still another plan for adoption when the fruit is the size only of a small pea. He finds the application of Paris green (arsenite of copper) very effectual in the proportion of 1lb. to 100 gallons of water. This fluid is used with a fine syringe or spray pump. It is essential, Mr. Cook states, to scatter the spray on all the fruit, and to use as little as possible at a time: seventy per cent. of the loss due to the Codlin Moth may be obviated by this procedure.—*L. O. Howard.* The danger in the use of so violent a poison is shown to be *nil*, as the latter is all removed before the fruit is ripe.‡

Extermination.—To extirpate the Codlin Moth when it has already manifested itself, or may be expected to do so, several methods are in

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* E. Meyrick. Proc. Lin. Soc. New South Wales; vol. vi., p. 657. (Sydney, 1882).

† Papers and Proc. Roy. Soc., Tasmania. Hobart, 1879, pp. 57-8. We have probably followed Mr. F. Abbot in making these recommendations without sufficient reason, for it is contrary to the experiences of the most careful observers, including C. V. Riley, that the Codlin Moth is attracted by light.

‡ *Vide* "*Gardener's Chronicle*," 19th June, 1886, Vol. xxv., p. 797; also "Report of the Entomolgogist," United States of America, 1887, pp. 103-115.

vogue—(1) The stamping out of the pest by destroying the whole of the fruit early in the season. At the Annual Fruit Growers' Convention, held in San Francisco in November, 1883, S. F. Chapin stated that this, which he referred to as "the starving out process," would be the sovereign cure. This we might infer from what happens when, without man's agency, such a process is accomplished under natural conditions of growth. The United States Entomologist, in explanation of a pretty general immunity from the attacks of the Codlin Moth shared by the apple crops of Michigan and New York in that year, adduced the general failure of the apple crop of the preceding year.* Again, F. Collet writes, in a paper read before the Fruit Growers' Convention of 1883, "The Codlin Moth dreads a damp and wet summer as being sure death to it," and "an unusually severe frost killed our whole crop of pears and apples, but with the good result of having pretty much starved out the Codlin Moth."†

In the event of this heroic measure not having been adopted, or in the absence of meteorological conditions affecting this total destruction of the crop, attention should be first given to affected fruit, whether fallen or still hanging on the tree. This should be sedulously gathered or collected and then burnt; or given to pigs as food, having been first boiled. This measure, however, need be promptly undertaken, owing to the short time which may elapse before the grub leaves the fruit when it has fallen. Operations, however, must not cease with this. The hiding-place of the caterpillar is next to be discovered and destroyed together with it; or better still the larva is to be tempted to seek the security which a spot for concealment, that has been prepared, seems to offer it. All dead and loose pieces of bark or moss from the ground upwards on the stem and branches of the tree are to be removed by the use of some blunt scraper, and the *débris* immediately burnt or buried deep in the ground. Many of the codlin moths in their caterpillar state will be thus destroyed; but others may yet be hidden in cracks and crannies, which even scrapers cannot explore. It is to reach these, then, that the following, amongst other methods, have been used: In the language of F. Abbot, "The tree, or such part of it having cracks or fissures, should then be dressed with some mixture that will set sufficiently hard to prevent any larvæ that may have escaped from obtaining an exit. There are many mixtures that may suggest themselves, but perhaps the following is as good as any—Mix powdered dry clay with sufficient coal-tar to form a thick paint, and work this mixture well into all cracks or crevices with a painter's brush. If this operation is properly performed there will be very few larvæ on the trees that will escape."‡

The most successful plan for checking the Codlin Moths in this caterpillar stage is to trap them, by a method already in vogue in the colony for intercepting caterpillars that attack the foliage of white cedars and other ornamental plants, on the way up the trunk of those trees. This trap consists of an old cloth placed in the crotch, or a band composed of sacking, canvas cloth, or stiff paper, fastened around the trunk of the tree, and should be set at the time when the affected apples

* "Report of the Commissioner of Agriculture." Washington, 1878, p. 238.

† "Codlin Moth—Report of the Secretary for Agriculture." Victoria, 1885, p. 5.

‡ Papers and Proceedings, Royal Society, Tasmania. Hobart, 1879, p. 57.

are falling. The following is the mode of procedure when the band is adopted: Strips of the material employed "should be cut about 6 or 8 inches in width, and long enough to encircle the trunk of the tree, lapping over slightly, and being folded, placed with the open end downwards upon the trunk, about 1 foot from the ground. A large-headed tack will safely and easily confine the band in place. The upper or folded edge of the band should be tight upon the tree, while the lower edges should be loose. Once every week these bands should be removed, and all larvæ found in them killed."*

That these methods will be successful is well known, save in the always possible event of neighbouring orchardists adopting different courses of procedure for withstanding the pest, or, what is more usual, not unanimous in adopting any at all. Still referring to experience in America, it is stated:—"This much we have found out, that if an orchard is located far enough from all other orchards the Codlin Moth may be altogether annihilated. The scraping of the trees, and the entrapping of the larvæ under bands, would effectually do it."—*F. Gillet.*†

How to keep the pest out.—The above measures are, then, sufficient when the moth has once established itself amongst the fruit trees, and upon it they are made to operate; but how to prevent its first appearance in the orchard itself should now claim our attention. This will be best done by strict adherence to the following injunctions:—(1) No pip fruit from a district in which the Codlin Moth is already prevalent should be brought into one in which its presence is not already manifest. (2) No cases which may have contained, or come in contact with, affected fruit should be admitted within the precincts of orchard premises, or only when they have undergone some process of disinfection such as "dipping them in boiling water (with or without the addition of an alkali) for a space of three minutes."

Even though worm-eaten fruit be not intentionally sent to market, it usually happens, and especially when this market is a far distant one, that the fruit is gathered when it is not fully ripe, or prior to the injury occasioned by the attack of the Codlin Moth being especially conspicuous. By the time the fruit has fully matured, the case containing it may be at or well nigh its destination, in which event the caterpillar will fasten its cocoon with usual secureness either in a crack in the case itself, or in some crevice in a neighbouring packing case. The fruit may yet travel further, with the grub still in it, and may arrive, say at Brisbane—as we have observed—harbouring the Codlin Moth in one of its stages. Happily, however, it is not yet established in any of the fruit gardens of the colony. In these its appearance will undoubtedly be sooner or later manifested, unless such preventive measures as are suggested are adopted, for under the commercial circumstances at present obtaining, both Tasmanian and American apples may now be purchased in the fruit shops of Toowoomba. April and May for Tasmanian, and September, October, and November for American fruit, are the months during which the caterpillar of the Codlin Moth may be looked for in the apples, from this source, offered for sale there, with much probability of its being met with.

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* "Codlin Moth—Report of the Secretary of Agriculture." Victoria, 1885, p. 5.—Extract from circular issued by the State Board of Agriculture of California.

† Extracted from the "Codlin Moth," and quoted in Report of the Secretary of Agriculture. Victoria, 1885, p. 5.

The Rot (*Glœosporium fructigenum*, Berk.).

This is a disease affecting both the fruit of the apple and the pear, and one of those which were noticed as occurring at Toowoomba. In the case of the former fruit, it was observed affecting the Irish Peach, and another apple the name of which could not be ascertained. The Beurre Clairgeau and Chaumontelle were the pears on which it was met with.

General description.—Pear, var. Beurre Clairgeau. Three specimens were gathered on 27th January, at Rosehill Gardens, Toowoomba, from a tree which had won the reputation of being a prolific bearer. Though within a week or two of ripening, these pears were still hard and green. In one, about two-thirds of the surface on one side was completely occupied by a dark coffee-brown discolouration, bounded by an irregularly waved outline. In addition, on the obverse side of the same pear, there were four irregularly shaped much smaller spots of similar character. The second specimen, affected on one side only, exhibited one large spot half-an-inch in diameter, and four smaller ones, and the third had one very large portion of discoloured surface, extending nearly from stem-insertion to eye, and several smaller spots of different size and shape. In each case the area involved in the changed condition was very noticeable, being separated from the normally green portion of the fruit by a well defined and abrupt line of demarcation.

In *Apples* the phenomena exhibited are very similar, although the areas involved in the affection have usually a more regular form than is exhibited in the case of the pear.

Progress.—With regard to the progress of the disease, Mr. Searle, having the instance of its development on the Beurre Clairgeau pear at Rosehill in view, remarked as follows :—" This affection appears in one or more spots in the first instance, and then spreads gradually from these as a centre over the sides of the fruit, so that the whole pear may have a rotten appearance and be actually in such a condition though still hanging on the tree." The Irish Peach Apple we have seen remaining on the tree until quite ripe. It is probable, however, that when the disease supervenes at an early date, so that the apple or pear is arrested in its development, the fruit falls. Thus the Hon. W. H. Groom writing concerning some badly grown and shrivelled up specimens of the above variety of apple which he had collected at Toowoomba early in December, 1887, and had submitted for examination, states :—" A red (? reddish-brown) blotch first appears on the side apparently exposed to the sun, and this spot spreading the fruit drops to the ground."*

Cause.—If a section of one of these fruits be made through the affected area it will be found that the altered tissue extends inwards almost to the centre ; but that it lessens in lateral extent as the more interior parts of the fruits are reached. If a diseased pear or apple is completely isolated and put on one side, it will be observed that the

* Mr. F. Lawson Scribner, Vegetable Pathologist, attached to the Department of Agriculture, U.S.A., in his report for 1887, mentions that his attention has been called to this disease, occurring at Denison, Texas, by reason of the large amount of fruit destroyed by it, and that " it begins while the apples are yet upon the trees, and in some cases the brown patches suggest that they may result from sun-scald." (*Op. Cit.*, p. 348.)

diseased surface shortly becomes covered with minute black elevations, and that, provided the fruit is in a moist atmosphere, there then issues from the centre of each of these a small mass or tendril of dull rose or fawn coloured material. Now, this is what we find so often occurs to both apples and pears after they have been gathered and stored and have commenced to rot. In the latter case we know the appearances are due to the presence of a fungus which grows on these fruits when they decay. This fungus is the *Glœosporium fructigenum*, which the Rev. M. J. Berkeley first described and figured in the *Gardener's Chronicle* of 1856 (*Op. cit.*, p. 245), and that this dull rose or fawn coloured material, which is composed of spores terminating short moniliform threads (basidia), is its external manifestation.*

Character of Fungus.—The fungus consists of slender threads (mycelia), which push their way through the tissue of the fruit. These threads are tubular, septate, sometimes branched, and ultimately brown-coloured. Rounded bodies (acervuli or nuclei) are formed by the fungus in places where the mycelial threads are so developed as to be matted together. These bodies, as the fungus grows, are found closer and closer to the surface of the fruit, until ultimately they break through it in simple or irregular pores, and thus arise small black pustules, emitting a pinkish viscid mass. A section through one of these acervuli shows that it consists of dark-coloured many-septate threads (basidia), which have their ends directed towards the ruptured cuticle, or protruding through it. Each of the very numerous basidia bears a spore (conidium) at its extremity. These conidia are oblong or cylindrical, often curved granular, hyaline and pinkish or fawn coloured. At the base of the spore-bearing threads (basidia) other bodies, known as pycnidia, may occur.†

Remarks.—Scribner has shown that the spores will germinate in water after ten hours' immersion; that mechanically injured fruit may be easily infected, but that that which has its surface perfectly intact cannot be infected. The puncture of an insect constitutes a sufficient starting point for infection, and an insect which has inserted its proboscis or ovipositor into diseased tissue is competent to convey the disease to quite sound fruit.

PEAR.

Fruit Fly (*vid.* "Peach," p. 54).

Leaf Disease.—The Phytopus Mite.

This disease of the pear is probably prevalent throughout the Toowoomba district. Attention was first called to it by a correspondent, who wrote in November, 1887: "I am sorry to record the fact that most, if not all, the pears in this garden are affected by some disease in the leaf—apparently a fungoid disease—and as far as my observation has gone I have reason to fear the fruit will be affected by the same disease." The specimens forwarded in illustration of these remarks were typical examples of the effect due to the presence of the

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* This opinion finds confirmation in the statement made by the celebrated authority, M. C. Cooke, to whom a portion of affected pear was sent through the Colonial Botanist, as to the presence of this fungus on the specimen submitted to him.

† *Cf.* P. A. Saccardo, "Sylloge Fungorum," fol. 54, p. 718, Batavia, 1884; W. G. Berkeley, in "Gardener's Chronicle," 1856, p. 245; W. G. Smith, *Op. Cit.*, 1885, p. 51, with figure; F. L. Scribner, "Report of Veg. Pathologist," Washington, 1888, pp. 348-50, pl. III., &c.

Phytopus Mite. The following description relates to the appearances which they presented:—"On stem and on fruit very light-brown scabs, with irregular margin, several in places confluent, most numerous on cheek of fruit. These scabs do not cause the surface of the fruit to be uneven, or the fruit itself to be asymmetrical; the leaves have on under surface light-brown, very slightly raised, spots or blotches, the margins of which are ill-defined. These spots appear under the lense to be minutely speckled, and each has one to three (according to the size of the spot) round circular holes. No fungus elements present." This disease may be thus characterised:—

Symptoms.—The presence of this minute insect on the pear tree is attended by a peculiar and characteristic appearance of its leaves.

"On examining a pear leaf that has been attacked some little time, a number of brown, blister-like looking spots will be seen. These are at first nearly round, but as they grow in size they spread latterly, generally taking the direction of the venation of the leaf. These are galls, for there is a decided thickening of the parenchyma, or inside portion of the leaf, and each gall contains a greater or less number of these mites. As the phytopi suck away the juices of the leaf or otherwise destroy the cellular tissue, it turns brown, and finally nearly black. . . . As the galls enlarge, owing to the food requirements of the population within, they often coalesce, so that in time the greater portion of the leaf becomes a blackish scab containing probably over 1,000 phytopi. On examining a gall on the underside of a leaf, one or sometimes more little holes may be detected with a magnifying glass. These are the outlets by which the inhabitants of the galls go forth. When a leaf is plucked, and begins to wither, the mites generally leave the galls, and they may then be found scattered about the leaf or else huddled together in some cranny."

Description of Phytopus.—"A full grown mite is about $\frac{1}{170}$ in. in length, and $\frac{1}{630}$ in. broad. It is of a pale reddish-brown or whitish colour, is cylindrical in shape, tapering at the tail end, its head ending in a rather sharp-pointed snout. It has four legs only, situated close together near the head, so that about four-fifths of the body has to be dragged after it when walking, which it accomplishes at the rate of four inches per hour. The legs end in a peculiarly shaped claw, at the base of which is a long curved bristle and a tuft of shorter ones. Three bristles project at nearly equal distances from each side of its body, the first pair springing from a kind of wart. At the tail end are two very big bristles, and two short ones between them. When the little animal is magnified about one hundred times it appears to be marked with a number of rings like a worm, but on applying still higher powers of the microscope, the rings change into—first, broken lines, and finally into rows of separate raised dots, like the markings on some diatoms."*

We have quoted from Mr. Crawford's account of the Pear Phytopus as met with at Adelaide, because there can be no doubt that the Queensland mite is identical with the one to which he refers; and the phenomena to which these acari give rise, and which he so well describes, are similar in both colonies.

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* "Report on the Fusicladiums, the Codlin Moth, and certain other Fungus and Insect Pests attacking Apple and Pear Trees in South Australia," by Frazer S. Crawford. Adelaide, 1886, pp. 46-48.

Mr. Crawford informs us that only one of his correspondents has suggested that any harm to the pear tree is occasioned by the presence of the Phytopus mite. He himself is, however, of opinion that "an insect that does such an amount of leaf damage must be injurious to the tree . . . . and even if it does no harm, the very unsightly appearance it gives to the foliage would make it desirable to get rid of it."

FRUIT ROT (*vid.* "APPLE," p. 50).

SPLITTING OF FRUIT.

The fruit of certain varieties of pear, notably the bergamottes, is very subject to splitting, especially after long-continued rain.

Cause.—The splitting is immediately due to the too sudden augmentation of the bulk of the fruit through accession to the amount of its aqueous constituent. This undue accumulation of water does not arise from a special determination of sap to the fruit during rainy weather, either through absorption by the roots or leaves, for the functional activity of these organs is reduced under such circumstance; but the fruit itself takes water from the atmosphere or rain precipitated upon it by endosmosis or transfusion through its surface from without, whilst it parts with some of its saccharine matter by exosmosis. That this is the true explanation of the occurrence, and is equally applicable to what happens also in the case of the grape, the nectarine, and the plum, is very evident from the experiments made by M. Joseph Boussing.* It is obvious, therefore, that the splitting of the fruit cannot be controlled by human agency.

QUINCE.

FRUIT FLY (*vid.* "PEACH," pp. 54-74).

WAXY SCALE INSECT (*Ceroplastes*, sp.).

During this investigation only a single instance of the Quince at Toowoomba being attacked by what we designate the Waxy Scale Insect came under notice. This was at Mr. Hartmann's Range Nursery, where it was observed to be plentiful upon the so-called Wild Quince. If it affects this variety there can be no doubt but that it will also live upon the fruit-yielding ones. It occurs on azaleas in Brisbane, and upon some native trees—especially the White Mangroves (Avicennia)—also. It is more commonly found, both on cultivated and wild plants, at Sydney. Oftentimes the insects are so massed together on a bough as to render it quite white, and a conspicuous object when viewed from a distance.

Description.—The scale insect presents the appearance of a small oval lump of smooth opaque white wax, with a slightly irregular surface and outline, measuring sometimes as much as $\frac{3}{8}$ in. length and height. On each side there are two little narrow clefts in the wax, which are opposite the spiracles of the insect. The insect itself lies imbedded in the wax, and is of a bright yellowish-red colour. When adult it is $2\frac{1}{4}$ lines in length. Directed backwards and obliquely upwards from the hind segment of the body is a long tubular organ.

Omitting a detailed account of this insect, we may add that it is difficult to determine its proper position amongst the Coccidæ. It is probable, however, that it is allied to *Carteria*.

* "Sur la rupture de la pellicule des fruites exposés à une pluie continué, &c."—*Comp. Rendus*, vol. 76, 1873, I.; pp. 776-9.

Remedies.—The thick waxy coating being impervious to almost every substance used as an insecticide, it is difficult at present to suggest a means of extirpating this pest. Its large size renders it easy of removal by scraping. Driving iron nails into the wood of affected trees, if useful in contending with some scale insects, as stated, might also in the case of this one be attended with good results.

CHAPTER III.

Diseases of Fruit Trees—Stone Fruits.

PEACH.

The Fruit Maggot, Fruit Fly (Fam. *Diptera*, Gen. *Tephritis*).

This is the larva of a small two-winged insect which develops from an egg deposited within the tissue of the fruit of the Peach, and within that of several other trees, and which lives at the expense of this tissue. It is, during some seasons, especially prevalent in Toowoomba, as well as in other parts of the colony. The study of this disease has been one of the main purposes of this inquiry.

All parts of Toowoomba were, during the season 1886-7, equally affected by the presence of the Fruit Fly, except that in some cases isolated trees occurred which seemed to owe their immunity to some accident of position, which, as the experience of previous seasons showed, would not exert a permanent protective influence. With the exception of the grape, passion-fruit, and medlar, all fruits grown in this district are said to be subject to injury from this pest. Our observations in the field tend to confirm the view, although no example of ripe or ripening fig containing the maggot of the Tephritis was brought under notice. As the result of a large number of experiments, we have demonstrated this to be so in the case of many kinds—in fact each of the following fruits—viz., apples (several varieties), pears, quinces, peaches, nectarines, plums, oranges, and shaddocks. All these are not subject equally to the attacks of the Fruit Fly, and the same remark applies to the different varieties of the same fruit. The condition most conducive to the presence of the maggot is no doubt afforded by the existence of succulency and sweetness combined, and thus peaches are more addicted to it than is any other fruit. At the same time the degree to which the flavour accompanying these qualities is pronounced has some influence on its occurrence in different fruits. Thus it happens that the maggot is not often noticed in the ordinary orange, and probably in the mandarin—where we have never observed it, or even heard of its existence in such situation—still less frequently. There can be no doubt also, since much independent testimony points to this conclusion, that fruits which ripen early in the season generally escape the Tephritis. Mr. G. Searle stated that early apricots and peaches were invariably free from the attacks of the Fruit Fly, but that during the season 1886-7 early pears were affected. The large variety of the China Flat peach which was ripe in November was uninjured, and so also were in great measure the smaller China Flats. Many orchardists, too, found that it was only the last gathered of the Royal George peach which suffered. So also with regard to apricots. The early fruit which ripened about the beginning of December was

free from the maggot at first, but a small portion of the crop gathered from the same trees later on was not unaffected. Later apricots ripening at the end of December were all attacked.

Symptoms, External.—It not infrequently happens that the fruit on being gathered presents externally no evidence of its being infested by the maggot of the fruit fly, and this circumstance leads to parcels, after they have been sent to the market as sound, being returned to the growers as entirely worthless. This we found to be a very common complaint at Toowoomba, and to emphasise this general experience Mr. R. Bushnell handed to us three peaches freshly gathered from the tree, and in quite a green state, at the same time challenging us to detect, without the most minute examination, any external sign of their being injured, and this we were unable to do. These peaches were delivered to us on the 28th January, and after they had been securely isolated they were put aside for subsequent observation, and on the 18th February it was noticed that five fruit flies had bred from maggots with which they must have been infested at the time of our having first received them. Other fruit, especially the pear, often also appears quite sound though, too, it afterwards proves to be maggot-eaten. Usually, however, there is some external indication—one side of a peach may appear dull green as if slightly bruised, and the surface of a pear or plum may exhibit at spots the appearances which would follow a similar injury to these fruits. At these places it will be found that the fruit is softer than at others, and that generally the juice will exude on pressure at one or two minute holes, which, however, in the case of the peach, may have been previously detected, especially when occurring in the lateral depression. At a later stage these punctures in each of which an egg has been deposited by the Fruit Fly, having meanwhile been enlarged by other insects, may become conspicuous objects, and the more so when, as often happens, they are surrounded by altered brown tissue. It may happen, also, that the surface of the fruit may be rendered uneven, and this is especially so when the latter has been early attacked. The following description of an infested apple may be taken as an illustration. In this case the surface of the apple appeared to have been "stung" all over, and although most of the holes caused by the punctures were now obliterated by the growth of the fruit itself, there was abundant evidence of the extent of the injury. The site of each puncture was marked by a minute dark spot, surrounded by a small halo of a darker green than was the general colour of the unaffected parts; these spots were, each of them, the centres of shallow depressions; these depressions were sometimes confluent. In cases where the last condition prevails, or the depressions are largely developed on one surface of a fruit, this becomes very unsymmetrical in shape. It sometimes happens that pears and apples when still green and hanging on the tree develop well defined patches or spots of a coffee-brown colour; these are found to be deep-seated and to be attended by the presence of a fungus. In several instances of fruit so affected, we have detected the maggot of the fruit fly by breeding the latter from such specimens, but in quite as many others have failed to do so, and this being the case we are not disposed to regard this canker-like disease as being due to injuries inflicted by this pest; but such injuries may afford the antecedent circumstance favourable to its establishment. (*Vid.* p. 50).

Symptoms, Internal.—An infected pear, when cut through, though it may show no signs of external injury, will exhibit numerous brown spots of different size, the sections of as many channels whose walls are composed of altered brown tissue, and which sometimes are the centres of much more extensive injury. At other times a zone of brown tissue surrounds the core. In a peach or in a plum the maggot seems to find its way quickly to the stone, and then to feed on the tissue immediately surrounding it, usually to a greater extent on one side than the other, devouring the pulp, leaving the more fibrous material and producing generally much semi-fluid matter as a product of decay. In a Free-stone peach the symptoms usually commence in the tissue immediately adjacent to the stone; but in a Cling-stone the injury seems for some time to be frequently limited to the part opposite the lateral depression, and between it and the stone. Eventually all fruit which is attacked becomes a mere "mass of corruption." It is important to note, however, that the fruit maggot never attacks the pips or stone of a fruit, nor yet the rind.

Extent of loss occasioned.—Insomuch as many of those who grow the fruits which the Tephritis Fly especially attacks keep no account whatever of their monetary transactions, it is quite impossible to estimate to what an extent the district of Toowoomba has been a general loser in bad seasons through the occurrence of this pest, nor do the railway returns of outward freight for one year, as compared with another, afford reliable information on this head. During our visit to the district due prominence was given to the fact that it is especially amongst the small German landed proprietors that most hardship is occasioned, for in their case the small estates which they hold do not yield sufficient to maintain the whole family, wherefore it is found necessary that the husbands shall work away from the cultivations during many months of the year, and throughout these the wives employ themselves amongst the vines and fruit trees. Now, any return which the latter will bring in is regarded as the wives' perquisite, and from this source alone has she often to entirely maintain the household, and, moreover, it is this fruit which, when preserved, provides her with a considerable element of food during many months of the year. The more or less complete failure of this source of supply therefore amounts, though not absolutely so, to a considerable loss in the case of these small proprietors. Amongst those who are not included in this category we may mention the case of Mr. Bushnell, who, during the second week in December 1884-5, lost £40 by reason of the failure of the apricot crop, owing to the presence of the maggot in the fruit. During last season Mr. G. Searle disposed of 114 cases of stone and pip fruit, for which he received value amounting to £52 17s. 6d.; but during the season 1886-7 he was only able to send 26 cases of these fruits to market, which realised £12 11s. 6d. Mr. M. Stenner in 1885-6 obtained £30 for his stone and pip fruit, but the following season only £8 10s. Mr. Heissle, as he also stated, during the bad season, 1884-5, despatched from Toowoomba fruit from which he expected to realise £300, but as this proved to be maggoty he had to content himself with receiving £46 only. During 1886-7 his loss of stone and pip fruits has been nearly complete. On the other hand, twelve years since he was able to send to market 12 tons of fruit per week, and during the season 1885-6, which was a good one, he forwarded two trucks full of fruit during every week also. Mr. F.

Lowe, who had charge of the garden at Raceview, estimated his losses during 1885-6 from the fruit fly at £50, and mentioned the fact that he could only obtain one case of sound peaches from several trees of the Royal George variety—one of the most valuable—and that he had calculated that of the fruit yielded by three peach and four nectarine trees he had lost no less than one and a-half tons. Again, Mr. J. Ibebb, of Stuart street, in 1885-6 sent to market about 120 cases of fruit—purchased from different small settlers—but in 1886-7, deeming that on account of the prevalence of the fruit fly it would not profit him if he did so, bought none at all for this purpose. Other instances of loss traceable to this pest might also be cited.

Description of Pest.—The following is a description of the insect in its different stages:—

Larva.—The larva of the fruit fly is a footless maggot of a white—often nearly transparent—colour. The anterior part of the body is pointed as it tapers from the 4th segment onwards towards the head. The posterior extremity of the body is obtuse, the caudal segment being obliquely truncated by the dorsal surface extending beyond the ventral and rounded from side to side. The intermediate portion of the body of the larva is almost parallel sided. There are ten segments, including the cephalic, and the union of each segment is marked on the under surface of the larva by a slight swelling, which bears two transverse rows of minute spines, the anterior of which is continuous, and the posterior interrupted. These spines, in the absence of feet, subserve a locomotor function. Below the head, and extending also on either side of it, there is a rasp-like cushion. This includes the mouth, which looks black by reason of the presence of mandibular organs of this colour. This rasp-like body is succeeded by a transversely rugose neck—a portion of the first body-segment. On the dorsal surface of the body there is on each side, just anterior to the union of the first and second segments, a very light trumpet-shaped body which is directed forwards (the edge of this trumpet is just seen from beneath). This is the cephalic spiracle. The edge of the trumpet is composed of two little frills, the outer of which contains more than eight segments. These cephalic spiracles are the outlets of the two dorsal main tracheæ, which extend backwards on either side of the body, giving off branches to each segment. In the anterior segments these tracheæ are more plainly visible than posteriorly, where they seem to be less superficially situated. They are united by a slender commissure in the last segment of the body, and terminate in two apparently evertible black tubular organs on the swollen upper part of this segment. These organs are the caudal spiracles, and behind them, on the inferior surface of the segment, are a pair of rounded tubercles, rather widely separated, one on each side of the middle line. The caudal segment is also armed with an inferior series of little plates, bearing each five or a less number of sharp teeth. These plates are utilised in connection with the springing movement. The anterior surface of the first body-segment is also armed with little teeth, which come into use whilst the maggot is boring its way through the tissue of the fruit, an operation largely assisted by the protrusible nature of the head, which also is transversely rugose behind, and has on each side, opposite this rugose portion, a few small teeth. The mouth is succeeded by a long lanceolate œsophagus, which suddenly

narrows in the middle of the second segment to a simple tube and then bifurcates. Length of larva, 9 mm. (0·35 inch.) ; breadth, 1·5 mm. (0·058 inch).

Pupa.—When the maggot of the fruit fly changes into the pupa it contracts in length, and its skin becomes the covering of the insect in this phase. The pupa is at first dark-coloured, and the principal segments of the body—eleven in number—may be recognised by lateral convexities. It is cylindrical in shape, rounded at the end, corresponding to the head of the larva, and slightly truncated at the other. After a time, as the contained insect increases in size, the surface of the pupa becomes smooth. It measures 0·175 inch in length, and ·09inch in breadth.

The Fly, female.—Maxillary palps, rather swollen at their base, light brown, clothed with minute appressed hairs, and a few larger erect ones. Clypeus broadly triangular with fore border shallowly excavated ; elevated along the middle line especially anteriorly, and sloping away on either side from the ridge thus formed ; a shallow groove for the insertion of the antenna within each lateral margin ; colour wax-yellow, glistening; a large black spot on either side. Front of even breadth, shallowly excavated from side to side ; an ill-defined dark brown spot in the centre, three short dark bristles along each lateral border. Vertex with the ocelli included in a dark brown spot, four stout backwardly directed bristles in pairs on each side of ocelli—one of each pair being on a lower level than the other ; five minute black hairs in a transverse line immediately behind each eye. Eyes large, brown. Antennæ reddish yellow ; the third joint long; dark brown on external surface ; bristles arising from near the base. Thorax with mesothoracic scutum and scutellum orange brown with two light, indistinct, scarcely separate, longitudinal mesial bands ; metathoracic scutum light yellow, scutellum (or hinder slope) brown with two dark brown longitudinal parallel bands. The scapulars of mesothoracic scutum, or prothoracic epimera, the mesothoracic epimera, a longitudinal stripe above the insertion of each wing, metathoracic parapleura (in other words the anterior lateral angles, a transverse suturally three divided patch in front and below wings, a two divided patch behind wings, and a stripe over each of these) shining light yellow. Upper surface clothed with a greyish pubescence of minute appressed hairs ; a tuft of longer white hairs at each anterior angle ; numerous brown bristles arranged as follows—four anteriorly directed on front border of thorax, three (two of which are within the yellow patch) in front of origin of wings, six backwardly directed on hind border of mesothoracic scutellum, two backwardly directed on hind border, and two anteriorly directed on lateral angles of metathoracic scutellum. Wings with two light brown stripes— (1) occupyingthe costal, marginal and inner half of the first basal cell, and extending along the marginal vein nearly to the fourth longitudinal ; (2) occupying the third basal cell, and inner side of third posterior cell. Remainder of wing, uncoloured, with iridescent reflections. Costal vein, first longitudinal and second longitudinal strongly setigerous ; other veins and membrane with short hairs more numerous on coloured portions of membrane. Halteres light yellow, spatula shaped. Legs brownish yellow, tibiæ in some specimens suffused with red brown ; clothed with hairs, those on the femora being longer and less dense than on other joints, tibiæ with

small striated spines at their extremites, most numerous on fore and least numerous on hind limbs ; a long stout spur also at end of middle tibiæ ; the first to fourth joints of tarsi armed beneath with small stout dark-coloured terminal spines. Abdomen (in female) ovate pointed, and somewhat acuminate, third, fourth, and fifth progressively, increasing in length and diminishing in width, clothed with very short appressed greyish pubescence ; second segment, with a light brownish yellow band encircling it behind, the anterior portion being brown, darker in the middle. Ovipositor long, the terminal pointed portion measures nearly $\frac{1}{20}$ inch (·0489″), and enclosed within the sixth and seventh abdominal segments, and usually exserted only to the extent of four thousandths of an inch, though when fully extended it may with the last abdominal segments reach a length of rather more than $\frac{1}{10}$ inch. The sheath enclosing the ovipositor proper, is lined with raised scales placed side by side in oblique rows in a tesellated manner. The exserted portion has a group of four outwardly directed stout hairs at its base, which hinder the ovipostor from being completely retracted, and the oviduct which is contracted opposite the origin of these hairs has a bulbous enlargement beyond them. Total length about $\frac{3}{10}$ inch (·292 in.). Expanse of wings rather more than $\frac{1}{2}$-inch, (·546 in. to ·565 in.).

The *Male* is recognised by its less robust form, its abdomen being obtuse instead of pointed, and by the presence of a group of black bristles on each lateral margin of the third abdominal segment. In other respects it resembles the female.

Habits.—The fly may usually be seen on a tree when the fruit is commencing to ripen, or when the latter has already passed this stage, and, having fallen, lies rotten on the ground beneath its branches. When settled it will be observed moving restlessly about exploring different bodies, especially the surface of maturing fruit, and when so occupied, though small, it is a very conspicuous object with its bright yellow markings and blue-green eyes. Usually its wings are directed backwards with the fore borders making an angle with the body, but ever and anon these are brought suddenly forward, retained in this position and quivered meanwhile. When disturbed it flies off quickly, but immediately alights again at no great distance off. When on a fruit it will be seen to examine with its protruded tongue different parts of the rind, especially those in the neighbourhood of any wound or injury which the fruit may have already received ; if it is a peach especial attention is paid to the place of attachment to the stem or to the lateral depression. On careful observation, too, the female insect may be noticed to insert the exserted tip of its ovipositor into the fruit at one or other of these spots. The question then arises—at how early a stage in the growth of any fruit is it liable to receive the eggs of the fruit fly ? This point, in the case of peaches, has been settled by Mr. G. Searle, who writes :—

" In 1875, in order to determine when the fly deposited its eggs in the fruit, I procured a quantity of book muslin, which I used in covering fruiting twigs on a peach tree, the fruit of which, I was told, was always maggoty—it was a rather late Slipstone. The first I covered was before the opening of all but one flower; the second just as the fruit was well set; the third, when the fruit had obtained the size of filberts ; the fourth, just after the stone had formed ; the fifth when the fruit was just beginning to lose its woody taste ; the sixth and last, just as the fruit was ripening. On all the twigs

covered there was more than one fruit, except that covered first, on which there was one only; and all, *except the last two covered*, ripened without being maggoty. The fifth covered had only two maggots in it, but the last covered was as bad as any on the tree, as was concluded from an examination of six which were picked haphazard from different parts, and placed in a jar until the maggots with which they were infested had become adult insects."

We find, too, that other fruit also is liable to be attacked thus early—even before it has reached its full size, and especially is this the case with apples. This was very evident from the appearance presented by some of this fruit which had been infected by the Fruit Fly, and which we examined at Ballard's Camp. These apples had grown subsequent to their having been attacked, although this increase in size was evidently arrested at the immediate spots which were the sites where the injuries had been inflicted. It thus often happened that the surface of the apple was disfigured by numerous shallow depressions; and, when these were restricted to any extent on one face of the fruit, this, owing to growth subsequent to the injury, presented a characteristic unsymmetrical appearance. It may also occasionally happen when the fruit is attacked thus early that the development of the maggot itself is arrested, since it cannot by its presence, during the progress of vigorous growth, determine those changes, analogous to decay, through which alone its movement from one part of the fruit to the other becomes possible, Thus, on cutting through an unripe apple, and especially a quince, dark markings may be noticed, from the occurrence of which, and from their character also, one might be led to infer the presence of the Fruit Fly maggot, although this cannot either be observed at the time or the fly itself be subsequently bred from the fruit. On the other hand, repeated observation has established the fact that fruit is always liable to be attacked by the Tephritis as long as it will hang on the tree, and previous to processes of decay having supervened.

The egg can be inserted by the female insect some way into the substance of the fruit, and this the fly is enabled to do by means of its sharp and long ovipositor, although it does not appear whether the function of the stout erect bristles on either side near the termination of that organ is to limit the extent of its insertion, or to facilitate it by fretting away the walls of the perforation. The number of eggs laid by a single fly has not been ascertained, although it is nearly certain that only a single one is deposited in each perforation. Several flies may visit the same fruit for the purpose of oviposition. The number of eggs laid in a single fruit may be estimated from that of the maggots which it subsequently contains. This in some measure is related to the size of the fruit itself; thus we have found as many as seventeen in a shaddock (and Mr. Searle states that he obtained an average of thirteen from three large peaches), whilst plums contain often but a single maggot apiece. In apples we have noticed from two to nine; in pears from one to nine; and in peaches from one to seven or more. The maggots are active little creatures both when in the fruit and after that they have been removed from it. Extending their heads through the decaying substance of the tissue they quickly draw their bodies along through it. When removed it will be observed that they can climb with facility up a perpendicular surface, provided that it is moist. They can travel over a plain surface by crawling at the rate of about six inches per minute, but when,

however, they adopt the method of leaping, they can cover four and a-half inches at a single bound. They are also able to work their way into any friable substance, such as ordinary soil. When fully developed they invariably leave the fruit, as we have found from quite a number of experiments; and so general is this habit, that the movement is not necessarily determined by the proximity of a substance in which the subsequent changes of the insect can be suitably undergone. They will thus then leave the fruit and drop into pure water, and so great is their vitality they will bear immersion in this for upwards of an hour without being permanently injured. In the case of a fruit which—like the Royal George peach—hangs long on the tree, they will even leave it whilst it is still in this position. On falling to the ground they immediately commence to bury themselves in the soil, provided it is soft enough to enable them to effect this purpose. This they do to the depth of quite an inch.* Should the soil be too hard, or in the event of their having alighted on a piece of sacking or wood, they nevertheless undergo their further changes in these unusual situations, even as if they had burrowed in the earth. The maggot changes into a small oblong pupa, and from this, after a longer or shorter period, emerges the adult fly. The time occupied in these changes varies according to the degree of temperature and also other circumstances. Increase of temperature hastens metamorphosis of larvæ in the pupæ and also of the latter into the adult insect, agreeable to the experience of J. Davison.† The amount and degree and saccharinity of the food also has some influence in determining the time spent in the larval condition. The completion of the full growth of the adult fly happens about forty days from the deposition of the egg, and from the time the maggot is fully matured to the appearance of the fly from fifteen to twenty days must elapse. It is possible, however, that during the heat of summer still less time is occupied by the different changes which the insect undergoes.

The number of generations born during a single summer is no doubt several, for the flies attack one fruit after another, as these succeed each other, until finally they infect the orange, which serves them until the commencement of the winter hibernation of the pupæ, which takes place in the ground. During the time occupied in this last phase of existence, they are not only subject to the attacks of carnivorus beetles, and other predaceous insects—as they are also during the summer after they have left the fruit upon which they have been feeding, but they also fall victims to the cold since the pupæ cannot tolerate a low degree of temperature. It thus happens, that after a season in which the flies have been especially prevalent, the following spring may be almost free from them; and especially is this so when also they become prematurely hatched, and cannot, therefore, meet with a suitable nidus in which to lay their eggs. On the other hand, a season in which they are so few that their depredations are scarcely noticed, may, owing to the suspension of the above causes

* These facts can with facility be observed when the insect is bred in confinement, and are the outcome of many experiments. Two samples also of soil which were taken at Toowoomba from beneath trees, the infected fruit of which was allowed to lie on the ground, were found to contain pupæ of the fruit fly, specimens of the latter being hatched out of them. Mr. G. Searle has also made similar observations.

† "On the Influence of Conditions on the Metamorphosis of the Blow Fly," Journ. Anat. and Phys. xix., 1885, pp. 150-165.

operating to check their numbers, be followed by one in which the survivors easily make their presence felt, and their unhindered increase by a ratio which is the measure of their individual prolificness, according to the laws of geometrical progression, is all that is required to create a formidable pest for the ensuing months of the fruit season.

The part, if any, which native fruits play in propogating the Tephritis has not been ascertained by us, and our efforts to breed the insect from indigenous oranges have not been met with a shadow even of success. Mr. G. Searle, of Toowoomba, however, informs me that "he has a large Moreton Bay Fig (*Ficus macrophylla*) growing close to the end of his house, and that having examined several of the figs as they ripened lately (*i.e.*, in February, 1887), he had found them all maggoty." From the context which accompanies these remarks, it appears that Mr. Searle regarded these insects which affected the figs as being identical with the grubs of the Fruit Fly, although we are not aware that he had established this identity by actual breeding. Until we are assured of his having done so, we are disposed to question his inference, seeing that (1) the fruit of fig-trees is habitually addicted to the presence of other dipterous insects, the larvæ of which might be perhaps mistaken for those of the Fruit Fly proper, and (2) no case of any variety of cultivated fig infested with the maggots of the Tephritis has been brought under our notice, either during our stay at Toowoomba or on any other occasion. It might be a profitable speculation, this investigation—the early source of the relation between the Tephritis and our cultivated fruits—had we positive information of its being associated with the native fruits of the scrub ; but until we have, we will refrain from entering upon such a subject.

History of its Occurrence in the District.—Mr. Bushnell, of Isaac Street, Toowoomba, stated that since 1853 he had been resident in this district, and during the whole period of his stay the Fruit Fly had done him more or less injury. The wife of Mr. Down, of Box Vale, Gowrie Junction, a settler who has long been interested in horticultural pursuits, informed us that when, thirty years ago, she first visited Gowrie, she made arrangements to take with her on her return home some peaches, and was only frustrated in her intention by the discovery on opening the box containing the fruit that each peach was infested with maggots. On the other hand, Mr. Heissle of the Middle Ridge, a fruit grower who has resided in the district for twenty-six years, stated that previous to the last twelve years no "maggots" were observed, and that owing to immunity from the attacks of the Fruit Fly, it was then possible to keep fruit as long as was permitted by the ordinary circumstances which induce decay, and pears especially could be kept then from one season to another. Moreover, wet springs and mild winters occurred formerly quite as frequently as now.* But again, Mr. G. Searle, of Rosehill Gardens, although not referring to the immediate neighbourhood of Toowoomba, states that in 1869 not only were the stone fruits destroyed by the Fruit Fly, but even the guavas also. We may, therefore, conclude that the Tephritis has been known as a pest on the Darling Downs ever since fruit has been grown there; but that, as Mr. H. Gorman, of Crone street, Toowoomba, also stated, it has only been within the last few years that this pest has been

* Mr. Heissle has, however, since modified this statement, for he did not intend to imply that the district was then entirely free from this pest.

so generally prevalent that its depredations have formed a subject of common complaint. Again, the probability of the Fruit Fly extending its ravages into districts where it has not previously occurred must be taken into consideration. As an instance of this, we may state a fact related by Mr. J. Porter, of Toowoomba, that at the Macintyre Brook Station (MacIntyre River, New South Wales), certainly no maggots occurred in peaches grown there twenty years since, whereas this fruit is now as much subject to the attacks of the Fruit Fly there as elsewhere.

Influence of Season on its Occurrence.—The fruit-growers of the Toowoomba district, guided by a common experience, are unanimous in their statement that a mild winter followed by a wet spring are the conditions favourable for the development of the Fruit Fly in such numbers as to become a formidable pest, and that, on the other hand, they have little to fear for the safety of their fruit crops when the winter has been severe and a dry spring succeeds it. On reference to a special report by Mr. G. Searle to us on the Fruit Fly, we find that when dealing with the specially prevalent occurrence of this pest in 1884 and 1885, he mentions the fact that in the season preceding—*i.e.*, 1883-4, and in that following—*i.e.*, 1885-6, the fruit was generally good, and suggests, as the only reason he can allege for this immunity during these two seasons—in the latter case the occurrence of severe frosts in July and August, 1885—the most severe of any known in the district for very many years; and in the former, the preceding dry winter and spring. In a similar way the bad season for the fruit of 1882-3 was ushered in by a rainfall in October, amounting to six or seven inches, and afterwards in December a good share of rain also fell. Again, on the subject of the bad season of 1884-5, Mr. Bushnell stated that during 1884 it had been dry up to Christmas, and that until the commencement of the new year the fruit was free from the maggot; but that afterwards by reason of wet and stormy weather, which began on the 3rd January, 1885, and the supervening warm days, he lost nearly all his fruit in three weeks. So, too, Mr. Heissle, of Middle Ridge, intimated that he regarded a mild winter as very conducive to subsequent attacks on the fruit by the maggot, and remarked that during the winter preceding the bad fruit season 1886-7, only three frosty nights were experienced, whereas a few years back it was a very ordinary occurrence to find the trees during winter quite cut back by reason of their severity. It will be remarked on examining Mr. Bushnell's testimony that he is of opinion that the character of the weather immediately preceding the time of fruiting has some influence in determining the freedom of fruit crops from the attacks of maggots. Mr. H. Hyer, of Crone street, too, stated as his experience that if two weeks of dry weather occurred just prior to the time of trees fruiting no maggots would be subsequently met with. The explanation of these facts seems to be that a mild winter is favourable to the survival of insects, in whatever stage they happen to be, which a severe one would interfere with; that a moist spring conduces to their being hatched from the pupæ; and that wet weather, by rendering the fruit succulent, causes it, when subject to the presence of the maggots, to undergo more readily those changes consequent on the injuries which these insects inflict, and which their proper alimentation and life involves. In a similar manner in the absence of these circumstances each of these events is hindered in its accomplishment.

Influence of nature and condition of soil on its occurrence.—From our observations, both in the field and the laboratory, it would appear that the nature of the soil—*i.e.*, its mechanical constitution and chemical composition, has little influence on the presence of the Fruit Fly. And this is especially the case when there is reason to think that the brood, or a great part of it, affecting a particular tree or orchard has been immediately derived from a distant source of infection. When, however, this is not so, there is little doubt that a heavy, clayey soil, which has previously been trodden down, does to a great extent diminish the virulence of any subsequent attack on the fruit of a tree growing with such surroundings, for the maggot does then, after quitting the fruit, find greater difficulty in effecting an entrance within the ground than when the soil surrounding the tree is both loose and friable and so easy to burrow into ; and the insect being so placed is either hindered in completing its transformations, and, consequently, dies ; or, if it does develop into the pupal condition, its position at or nearer the surface than it would otherwise be affords unusual opportunities for the onslaught of those enemies which naturally prey upon the Tephritis in its earlier phases—the numerous geodophagous beetles amongst insects and poultry amongst birds. As bearing on these conclusions, the following cases may be cited :—

(1). Adjoining one of Mr. Roessler's cultivations at Toowoomba there is a small paddock, of about one acre in extent, in grass, with a few fruit trees growing here and there in it. Stock are constantly feeding in this enclosure, and as a consequence the ground of the paddock gets well trodden upon and is hard. The adjacent cultivation, on the other hand, being well tilled, the soil of it is accordingly very loose. Now, the fruit in the latter proves to be very much affected by maggots, whilst that produced in the small paddock is comparatively free. These facts were mentioned to us by Mr. Roessler himself, and their explanation seems to be that the immunity of the fruit from attack in one case was occasioned by the circumstance of the ground being too hard for the maggots to effect a lodgment in it during the preceding winter, whilst in the other the state of things existing was favourable to this action on their part. As an alternative explanation it was suggested to us that the high cultivation in the latter instance by rendering the fruit juicy and soft had caused the flies to visit it in preference to that on the neglected trees which did not possess these characters.

(2.) At Mr. Hartmann's nursery, a peach tree growing near the house, on quite hard ground was pointed out as one whose fruit was not, during the season 1886-7, infested by the maggot, although other peach trees growing at only a short distance away were by no means free from its presence. In this case we have hard, comparatively impenetrable ground, an indifferent non-succulent fruit, and also the presence of fowls to destroy the fallen fruit of previous seasons, as facts in accounting for the absence of the Fruit Fly.

It is the general opinion in the district that cultivation has no influence in protecting trees from the visitations of these pests, nor have our observations led us to come to any other conclusion. The same may be said of neglect of cultivation, but in this case we have the additional loss due to the fact that the fruit saved is of an inferior quality only.

Range of occurrence.—At Kiama, to the south of Sydney, grubs similar to those of the Tephritis were noticed in the peaches raised there by Mr. Bushnell, as he informs us, as early as 1853. And Mr. MacStay, another resident of Toowoomba, who formerly had much experience as a horticulturist in the parent colony, stated that if much rain was about, the fruit growing in the gardens in the district of Sydney was not worth gathering, owing to the extent to which it would be infested by the Fruit Fly maggot under this circumstance. Again, there is reason for believing that an insect "which has been destructive amongst the apples in some of the orchards in the colony of New South Wales," and which the secretary of the Fruit Growers' Union, in a letter, dated 2nd April, 1887, from Parramatta, described as "a small grub which penetrates the fruit," is not "the 'codlin moth' which it is believed to be," but is rather the maggot of the Fruit Fly. Its occurrence in the northern districts of New South Wales has been well ascertained, and it infests peaches there as far west as the McIntyre River, according to the evidence of Mr. J. Porter, of Toowoomba. It is very prevalent in peaches grown at Brisbane, and during this last season, 1886-7, was very destructive to this fruit as far west as both Roma and Surat. Its northern range has not been ascertained, and although Mr. W. T. Grant, recently residing at Neams, Ingham, states concerning a single peach tree growing at Macknade, on the Herbert River, that "it never ripened peaches owing to the presence of maggots." His statement does not necessarily imply the existence of the Typhritis fly, in this instance of injured fruit; and his other remarks rather pointed to the presence of another insect pest affecting peaches in that district.

Remedies.

To protect fruit from attack when the fly is about.—For this purpose we would suggest that the following methods be tested, which have for their object (*a*) the destruction of the adult insect, and (*b*) the repulsion of it from fruit-laden trees :—

(*a*) A fly poison to be placed in such situations as the insects are known to frequent, and especially in proximity to ripening fruit. In preparing such a substance, take ¼ ounce of quassia in small chips, and boil it for some time in sufficient water to eventually produce 1 pint of infusion. To this add 4 ounces of treacle or molasses, and stir well the mixture. This substance might be smeared on plates, flat dishes, or similar bodies, and being eaten, the narcotic fly-poison quassia will make its presence felt.

In order to render this mixture still further attractive, some fruit essence might be added to it, and there are several of these which are well known to the confectioner's art. For it is well ascertained that flies are attracted to substances, which they visit either for supply of food or as situations in which to deposit their eggs, chiefly by the aroma which these substances exhale, and through direction of the sense of smell; and inasmuch as this is the case, the feasibility of attracting them to bodies for the purposes mentioned, but which are not suitable for these purposes, exists. This might have been concluded from the well ascertained fact that, flesh-eating flies, attracted by the fœtid odour exhaled by the flowers of Arum dracunculus visit that plant, and, still undeceived, deposit their eggs upon it in a similar manner

to what would happen in the event of its being a piece of putrescent meat. Whether the risk of killing bees would be incurred by this method can alone be ascertained by experiment.

(*b*) To repel the fly from fruit which it may seek to attack, advantage may be taken of the fact that many odours appear to be highly objectionable to insects. This is so in the case of tallow, which is known to be repugnant to many beetles which live on other animal matter; and in that of the vapours of coal-tar, wood-tar, and other similar bodies which are equally deterrent to these and other pests. To quote an instance of the value which resides in the latter substances, from the possession of this quality, we may be permitted to allude to the following practice, and which as it refers to the attacks of a dipterous insect it is not altogether *inapropos*, in vogue amongst the employés of the Hudson's Bay Company to protect their domesticated animals from "the black fly," so troublesome in the northern woods of America:—

"A quantity of coal-tar is placed in the bottom of a large shallow receptacle of some sort, and a smal quantity of oil of tar or oil of turpentine, or any similar material is stirred in. The receptacle is then filled with water, which is left standing for several days until well impregnated with the odour, and the animals are then washed with this water as often as it seems necessary."*

We would therefore suggest the adoption of a plan which has for its object the maintaining, during the whole time that the fruit tree is liable to the attack of the Tephritis, the presence of some noisome odour amongst its foliage. For this purpose we recommend, then, that lumps of tow, which have been previously soaked in creosote or coal-tar, should be suspended amongst its branches. Failing this, advantage might be taken of the antipathy which many insects have for vinegar.†

(*c*) The practice of using "Fly Nets" to protect the face from the visitation of flies suggests the possibility of a simple thread-net, having meshes of much larger dimensions than would admit of the passage of a Fruit Fly, being of service in protecting the crops of fruit trees from the attacks of these pests. At the commencement of the first volume of the "Transactions of the Entomological Society of London" we are informed of "A mode practised in Italy of excluding the common House Fly from Apartments," which consists in extending across open windows a thread-net with meshes an inch or more in diameter, or merely extending threads at intervals from one side of the

* Report of Commissioner of Agriculture, Washington, 1884, p. 345.

† According to information emanating from the Imperial Society of Practical Horticulture of the Rhone, and from the School of Arboriculture of the Parc de la Fête d'Or at Lyons, the mere odour of vinegar is enough to drive away, and in some cases even to destroy, those insects which deposit their eggs in blossoms of fruit trees—insects which are accountable for very great losses. As the result of experiments undertaken by the director of the above school as long ago as 1865 it was found that fruit trees treated with diluted vinegar were covered with fruit, while those to which the acidulated water was not applied bore scarcely any. "The mixture recommended consists of one part of vinegar to nine of water (but as French vinegar is very strong, perhaps the amount of water should be less when English vinegar is used). When the liquids are well mixed, the solution is to be sprinkled over the flower-buds by means of a garden engine or syringe." With this statement before them our fruit growers will have no difficulty in devising an experiment to test whether vinegar has or has not any influence in repelling the Fruit Fly.

window-frame to the other. It is essential, however, that the light enter the room on one side of it only, for if there be a *through* light either from an opposite or side window the flies pass through the net without scruple." In fact, as we are reminded, the residents of Florence and other Italian cities merely adapt a method which the Egyptians, according to Herodotus (*vid.* Book ii., Cap. 95), employed in warding off the attacks of mosquitoes—*viz.*, that of sleeping under cover of the wide-meshed *amphiblestron* or casting-net, which served them during the day for the capture of fish.

2. *To obtain immunity from the attacks of the fly for succeeding crops.*—Any remedy which may be suggested with this end in view must take into consideration the facts, previously though only partly set forth, concerning the habits and life history of the insect, and we insist on this very obvious requirement seeing that plans have not only been suggested in the Press, but contended for also, which, through not complying with it, are of a most ridiculous nature, though in the case of other insects having habits very different from those of the Fruit Fly, they might be commendable enough.

We therefore recommend as follows:—

(1.) The fruit should be gathered as soon as it shows unmistakable evidence of being infested by the Fruit Fly, and at the same time any fallen fruit should be gathered up; or if the fruit is left still hanging on the tree whatever does drop should be quickly collected. Without delay the material thus obtained should be destroyed either by fire or by feeding pigs upon it, and in the latter event, preferably, after having been first boiled.

(2.) Fowls, and ducks especially, should be allowed to feed under infested trees.

(3.) Some caustic substance should be placed immediately under the trees to receive the infested fruit, and into which the maggots might crawl after having quitted the latter. We should give the preference for this purpose to any material which might become a fertilizing agent, and which possessed an odour which of itself would serve to repel the adult insect from an orchard. The "spent" lime, which remains after the purification of coal gas by the use of slacked lime, appears to be most suitable for this object. This substance, usually known as "gas lime," is generally regarded by manufacturers as a waste product,* and has the advantage of being adapted for fertilising purposes, to a greater extent than would otherwise be the case, after it has been exposed for some time to atmospheric agencies. A depth of two inches beneath any fruit tree would be sufficient to achieve the object sought to be accomplished, and after it has served its purpose the gas lime should then be dug in. (*Vid.* "Woolly Aphis," p. 36).

In suggesting these remedies we would point out that, in view of the fact that (1) the extent to which this pest makes its presence felt is largely connected with the prevalence or not of certain meteorological conditions, this being so much the case that in some

* Gas lime, according to Messrs. A. Mayers and F. Clausnitzer's Analysis (*Bied. Centr.*, 1882, 852), contains water, 30·1 the following salts in the proportions mentioned, viz., calcium hydroxide 32·6, carbonate 17·5, sulphate and sulphite 20·2; sulphide traces; thyocyanate traces; and ammonia 0·01. Total 100·4. (*Journ. Chem. Soc.* xliv., 1883, p. 506.)

seasons, even those which have succeeded to one in which the fly has been very destructive, fruit obtains an almost complete immunity from it, and (2) since there is reason to think that a supply will always be kept up from native sources alone—*i.e.*, from the imperfect wild fruits of the scrubs of the district, to perpetuate the existence of the pest; the best result will accrue to fruit growers from the adoption of a method which will repel the Tephritis from the fruit itself. And this will especially be the case when any plan adopted for the destruction of the insect is not generally acted upon throughout the district, and fruit trees here and there unattended to exist as centres for general infection. Again, the destruction of the maggot of the Fruit Fly out of consideration of the safety of other fruits, whether of the same kind or not, whose season of maturation has not yet arrived, will be attended by the best results or will alone be beneficial when taken in hand early in the season on the first symptom of the recurrence of the pest; and it is even worth consideration, though we are not for the practice, whether it would not be advantageous to sacrifice the whole crop of early fruit and so allow these flies which have arisen from their winter sleep in the ground—and this probably happens within a few days simultaneously throughout the whole district—to perish without having had an opportunity of propagating their kind—no suitable nidus existing in which to place their eggs. But we would insist on destructive measures being generally adopted, if at all; for in favourable seasons, so rapid is the development of the insect, a few infested and neglected trees, or even the existence of a few individuals here and there will suffice to distribute the Tephritis through an entire district. This is the explanation of the common opinion that in one season there are no Fruit Flies, whilst in the succeeding one they are especially prevalent; for their absence is not an absolute one, and they are present, but not so numerously so for the fact to form a subject of comment.

NOTE.—The introduction of American evaporators into the district, and the production by their agency of that quality of dried fruit which is white, or still retains much of its original colour, would, by supplying an article of commerce, which is in great demand in other countries where it has a high marketable value, doubtless help to diminish the losses which might otherwise accrue to fruit growers through the injuries occasioned by this pest. For although fruit, when once infested by the Tephritis, may generally be abandoned; in those cases, however, in which the maggot has not arrived at its full growth, and when therefore the greater part of the tissue is as yet sound and wholesome, the fruit is still available for drying, since any injured parts may, with little additional labour, be easily separated whilst the pairing process is being conducted, and prior to the fruit being admitted into the evaporator.

Other suggestions.—A good proportion of the ill effect due to the Fruit Fly might be obviated by having regard to the proper time at which to gather the fruit. Experience at Toowoomba taught us that fruit-growers there seldom sought a market for their fruit until it was ripe, when they proceeded to gather it in. With regard to most fruits, it is a well ascertained fact that no colouring or organic matter enters them after they are full grown. A well-known writer on the subject justly inquires, " What result, then, can be attained by leaving fruit on

the trees after it ceases to grow, whether it is full or under-sized? The only advantage possible is the mellowing of the fruit so that it may become more palatable." Now this mellowing, and the ripening also of the fruit, takes place more rapidly after it has been gathered and placed within doors, though the processes on which these results depend are hastened or retarded in their operation according as the temperature to which the fruit is exposed is lowered or raised. The temperature to which the fruit is subjected when within doors is more equable than that it would experience if left to hang on the tree, and so the process of ripening proceeds with greater regularity. Early gathering also serves not only to retain the much-admired blush of the fruit, but its colour after the fruit is gathered is heightened even when it is kept in absolute darkness. Further than this, early gathered fruit has the better keeping quality. Fruit should never be allowed to hang on the tree as long as it will, for many fruits will remain on beyond the time when they are fit to gather. Pip fruit should be gathered, if pears, when the stem parts easily from the fruiting spur, and others when the centre of the fruit is dry, and the seed has become a brown colour, rather than leave it until the pips have changed from brown to black. It has been concluded that in the case of several fruits the Fruit Fly only attacks them when the first stage in the ripening process has commenced—when the starch is changing to sugar, and the cohesion of the constituent particles is rendered less pronounced. These statements, however, though of general application, are not true in every case, and there are some quinces which, unless left upon the tree until fully ripe, are found to be hard on cooking; but even in the case of the quince we noticed at Toowoomba perfectly sound fruit, which had shed its pubescence, still left hanging on the tree, it being at that time so mellow as to attract flies, and among them the Tephritis which was alighting upon it.

Fruit Flies of analogous habits in other countries.—Any facts pertaining to the nature and habits of Fruit Flies in other countries may be expected to throw light on some of the obscure points connected with the life history of the Queensland insect, and fruit-growers here, too, may profit by the experiences of those who have elsewhere studied these pests. We will consider, then, the several insects under the names of the particular fruits to which they have been found to be so injuriously related.

The Apple.—We are not aware that the apple is attacked by any Fruit Fly in Europe, but in the United States an insect closely related to our Queensland fly is regarded as one of the pests of this fruit since it eats into the pulp of the latter and causes it to decay. The following facts relating to the Apple Maggot (the name by which it is known in America) are derived from a "Report on Miscellaneous Insects" which forms part of the annual report of the Commissioner of Agriculture, Washington, 1881-2. Professor J. H. Comstock therein states that the fruit fly injurious to apples there is a native American insect which has developed a taste for some varieties of apples:—

"The apple maggot is a native American insect, which naturally feeds on the different species of hawthorn (*Cratægus*) and upon crab apples. It is probable that this insect occurs throughout the country wherever hawthorns or crab apples are found. Mr. Walsh observed it long ago as far west as Illinois, and I have bred the adult insect from a species of Cratægus, growing in the agricultural grounds at Washington."

It would appear that it has a predilection, or almost entirely confines its operations to certain kinds of apples, and "is much more apt to infest earlier apples than the winter varieties" It does not readily, in all cases where it occurs on native plants, extend its operations to the cultivated fruit, and accordingly its ravages are not everywhere experienced. Thus Mr. Comstock remarks: "Although Mr. Walsh bred this insect from haws in Illinois twenty years ago, I can find no record of its infesting apples in that State yet." And again, "although I have observed it for several seasons in one of the orchards of Cornell University, I have found it only in a few varieties of fruit." The ripest sweet or mellow sub-acid fruit apples are mostly affected by this fly. The *nature of the injury* occasioned by its maggot is thus described: "This insect . . . . bores tunnels in all directions through the pulp of the fruit; frequently these tunnels enlarge into cavities the size of a pea, and when several larvæ are present in the same apple it is honeycombed so as to be rendered useless." The *extent of the injury* for which it is responsible may be gathered from the following statements: "We have more to fear from this insect than from any other that preys upon the apple in New Hampshire." "It is usually so abundant wherever it occurs that it destroys a large proportion of the fruit," and "It will be seen at once that the injury done by this pest is even more serious than that done by the Codlin Moth." This insect has been described under the designation of *Trypeta pomonella.* The *adult* measures from one-fifth to a quarter inch in length. It has a red head, with black eyes; a black thorax (mid body) with white stripes and a white spot behind; a black abdomen, having transverse silvery stripes above, and wings, which, otherwise clear, have four black crossbands. The characters presented by the maggot and pupa of this insect somewhat resemble those afforded by these earlier stages in growth of the Queensland insect.

As concerning *remedies*, Professor Comstock writes:—"The more practicable way of lessening the injuries caused by this pest are the destruction of infested fruit promptly after its fall from the tree, and before the maggots leave it to go into the ground to transform; and when the pest is very abundant, the grafting of the trees into varieties less liable to be infested. In such a case it might be well to leave one or two trees of early apples to serve as traps, and promptly destroy the fruit as it falls from them. If such fruit could be enclosed, and sheep or pigs pastured under them, the success of the trap would be assured."*

Cherry.—Although Miss E. A. Ormerod in her interesting "Manual of Injurious Insects" makes no mention of the fact of the cherry being attacked by a fruit fly, this is undoubtedly the case, if not in England at least in other European countries. Messrs. Kirby and Spence state that the "Cherry-fly (*Tephritis cerasi*) provides a habitation for its maggot in the fruit (cherry), which it invariably spoils."† Bach has given some account of the habits and natural history of this insect, otherwise known as *Spilographa cerasi* (Linn.). From this it appears that in Germany, towards the end of May, the female lays her eggs in the cherries by inserting her ovipositor near the peduncle. The larva, when hatched, eats obliquely in towards the stone. When full grown the larva quits its cherry by the same passage, falls to the ground, and changes to the pupa at a depth of about an inch beneath

* *Op. cit.* p. 198.

† "An Introduction to Entomology."—Vol. i., p. 198.

the surface. The remedies recommended for destroying this insect are deep digging of the ground under the trees in the spring, or pouring acid or other corrosive fluids upon the damaged fruit after the latter has been gathered.*

Orange.†—Latreille writing in 1816 on Tephritis remarks: "The colonists of Mauritius are scarcely able to obtain any sound and perfectly ripe citrons, in consequence of the extreme multiplicity of a dipterous insect of the same subgenus which deposits its eggs in this fruit." ‡ This passage is repeated, with scarcely any modification, in an English translation of the work from which this quotation is derived.§

J. O. Westwood, the editor of the entomological portion of the work last referred to, further tells us that, "A small but beautiful allied insect has been described in detail by Mr. Macleay (Zool. Il., No. 16, 18) under the name of Ceratitis citriperda, the larvæ of which feeds upon the pulp of ripe oranges. The male is remarkable for possessing two minute clavate filaments on the crown of the head." ||

No copy of the Zoological Illustrations is available, and so this memoir of W. S. Macleay cannot be referred to. However, in the *Zoological Journal*, Vol. iv., Art. lx., pp. 475-482, there is a letter from the same authority to Vigors, on a "Notice of Ceratitis citriperda, an Insect very destructive to Oranges." Macleay remarks that of the quantity of oranges imported from the Azores, about two-thirds only are generally of use, and that sometimes whole cargoes arrive in a state of decay. The soundness of the oranges, moreover, varied with the season, and even with the year, and there was reason, from this and other considerations, to conclude that the mischief originated from the oranges being unsound when shipped. This decay of the St. Michael oranges was during the end of their season—namely, during the months of March, April and May—accompanied by the presence of the larvæ of a small fly, specimens of which could be bred from the larvæ to be found in almost every one of the damaged oranges retailed by the barrow-women in London during May. The original puncture of the ovipositor of a fly remained visible in the centre of the soft part of the rind, and thus was a proof afforded that the maggot was the cause of the decay. Macleay communicated with M. Cattoire, whose statement is quoted by Latreille, and so obtained a specimen of a fly which in the Mauritius had been reported, as we have seen, to injure the fruit of the citron, or, rather, as he then learnt, that of the orange, and he was led to remark how slight was the difference between it and the fly derived from St. Michael oranges—the former being scarcely more than a variety of the latter.

* "Verhandlungen des Naturhistorischen Vereins der preussischen Rheinlande und Westphalen." Bonn, 1868. Corr. bl., p. 58.

† Examples of the Queensland Fruit Fly, found attacking oranges, were sent, in 1878, to the Colonial Office, and on 21st November, 1878, the Secretary of State forwarded a despatch to the Governor, covering a letter from W. T. Thistleton Dyer, Assistant Director of the Royal Gardens, Kew, communicating the substance of a report by Mr. R. McLachlan, F.R.S. In the latter, Mr. McLachlan states that "the fly that attacks oranges is allied to, but probably distinct from, the genus *Ceratitis* known as destructive to oranges in Madeira"—Vide *Votes and Proceedings, Queensland, 2nd Session* 1879, vol. ii., p. 985.

‡ Cuvier's "Règne Animal." Paris, 1816, vol. iii., p. 647. *Trans.*

§ Cuvier's "Animal Kingdom." Lond., 1840, p. 635.

|| "An Introduction to the Modern Classification of Insects." Lond., 1839-40, vol. ii., p. 573.

Appearance of Infected Orange.—"An infected orange," writes Macleay (*Op. cit.*, p. 481), "may be at once known by a greater or less portion of its rind being withered, and showing evident symptoms of decay, in having lost its firm consistency and texture, and in having changed the usual brilliancy of its colour for an opaque and dull olive yellow. The size of this withered and discoloured spot must, of course, in a great measure, depend on the havoc committed in the orange by the concealed insect. While, however, the fly is in its larva state, this spot appears to vary from a space that might be covered with a sixpence to one that might be covered with half-a-crown. In the centre we may perceive a small white orifice, which is the puncture of the parent insect, and which in general may be distinguished with ease from the orifice made by the larva previous to metamorphosis by a certain whiteness of the sides, which appears to result from some mould or other vegetable of that nature. On opening such a fruit as has just been described, we discover the whole space from the discoloured spot to the core to be in a state of perfect decay, the juice having disappeared, and the fibres being completely decomposed, and covered in a greater or less degree with that blue and white mould which is usual in decayed oranges. The rest of the orange is usually entire, but so desiccated as most imperfectly to represent that pulpy substance, which in a good St. Michael's fruit is so replete with juice. It is revelling in the decayed part of the orange that we find the larva of our fly, which, when of sufficient maturity to emerge from it, undergoes its coarctate metamorphosis outside the fruit."

Mr. Macleay adds in a note that he has seen the mature fly also on oranges at St. Jago and also at Funchal, and also that he has heard that a maggot infests the oranges in the West Indies.* The description of this interesting insect is deferred, but there can be little doubt that it differs from the insect with which we are more immediately concerned; as we gather, (1) from the statement that the male fly "is most remarkable in an entomological point of view, for having two clavate subarticulate horns planted between the eyes, so as to make the insect appear provided with two anomalous antennæ in addition to the ordinary pair"†; and (2) from an inspection of the figure which accompanies his paper.

Mons. de Brême has described under the same name *Tephritis citriperda* another orange fruit fly. This is now known as C. capitata, *Wied.* According to Laboulbène, this fly has somewhat different habits, although its attacks on the fruit lead ultimately to the fall of the latter. He states that it appears to produce a gall in the peel of the orange in which the female Tephritis deposits her egg, and that the injury does visibly extend beyond the peel.‡

A fourth orange fruit-fly occurs in Mexico. It is allied to the Queensland insect, and named *Trypeta ludens*, Loew. (Review of N. A. Trypetina, Mon. Dipt. N. A., Part III., Sm. Inst., 1873, p. 223, Pl. XI., Fig. 19). In its case "the *full-grown larva* is three-eighths of an inch in length, of a dirty white colour, with the extremities brownish. It may be readily distinguished from the other larvæ so far

* May not this be the larva of *Conops quadri-macula*, Ashmead "Orange Insects," p. 69, f. 23, an insect belonging to quite a different family of Diptera than does the Tephritis citriperda or our Queensland fruit fly.

† *Op. cit.*, *p.* 482.

‡ Annales Soc. Ent. Fr. (5), pp. 439-443. Paris, 1871.

known to affect oranges by the two anal spiracles, each with its three transverse slits. The *puparium* is shorter ($\frac{5}{16}$ inch), oval, and of a dark-brown colour. The general colour of the *perfect fly* is ochre yellow, with slightly darker markings. The markings on the wings (which expand $\frac{7}{8}$ inch) are yellowish toward base and smoky toward tip. The following description of an affected orange may serve for comparison with what is known concerning the local pest: "Upon opening an orange it was found to contain a couple of holes immediately under the skin, penetrating into the interior. Further investigation showed the orange to contain eight dipterous maggots measuring 10mm. in length. A careful examination of the outside surface revealed no signs of entrance, but the inner pulp of the peel contained a minute perpendicular burrow, which was continuous with that of the hole in the interior of the fruit. The eggs were evidently deposited in one of the pores of the skin or upon its surface, from which the freshly-hatched maggots entered." Ultimately the fruit "rots and moulds, and about one-half of the pulp is devoured, although the outside does not show it." The existence of this fruit worm in Mexico has for some time past caused some alarm in the orange-growing regions of the United States, and it has been made the subject of a special note by the United States Entomologist.* It has been from this source that the above information has been obtained.

The Olive.—In all the agricultural districts of Italy and the South of France the olive has from time immemorial been attacked by the larva of a fly which, according to M. Guérin-Meneville, who was commissioned to inquire into the ravages caused by it in 1846, occasioned destruction during the years of its visitation, estimated as amounting to 6,000,000 francs worth of oil. Though a different insect, in habits it closely resembles the Queensland Fruit Fly. It places its egg in the olive, the egg hatches in this situation, and the resulting maggot devours the parenchyma of the fruit, and thus destroys all parts susceptible of yielding oil. When subject to this injury the olive drops from the tree, whereupon, or shortly afterwards, the maggot emerges from it, enters the ground, and there undergoes its changes, remaining in the chrysalis state until the middle of the heat of summer when it comes forth a perfect fly ready to attack other olives. If worm-eaten fruit is pressed with that which is sound, the oil instead of being of the usual colour and clear, is dark and turbid, and so has little or no market value. It is interesting to notice the nature of the remedy, which Guérin-Meneville suggested as a preventive against future attacks. He remarked, "It is clear that it will suffice to *abbatre* the olives and to press them some time before their maturity, when the larvæ have not yet grown to their full size, and prior to the time when they are sufficiently advanced to leave the fruit and enter the ground." He added that little oil would be obtained by thus operating on the fruit at a time when all the oil was not yet formed; but then the little which was obtained would be far better in quality than would be the dark and infected fluid, the produce of olives fully ripe but bored through and through by the maggot,† and, moreover,

* *Vid.* U. S. Department of Agriculture, Division of Entomology, Periodical Bulletin, Aug., 1888, Vol. 1, No. 2, pp. 45, 47, Fig. 9.

† *Comptes Rendus*, 1846, t. 23, pp. 262-4, in an article entitled "Note sur un procédé propre à détruire les vers qui rongent le parenchyme des olives, et sont cause de la perte des récoltes d'huile."

one would be certain to destroy all the larva contained in the unripe olives, and so ensure for the following year results which would fully compensate for loss, owing to the adoption of this procedure in the previous one. He added, however, that the execution of such a plan would have to be co-extensive with an entire district, and performed under the surveillance of the Government, or of local authorities.

In 1852 M. Guérin-Meneville announced that his method had been adopted by intelligent agriculturists, and that his counsel having been taken into consideration by the authorities of Piémont, they had passed a law making it obligatory on the residents there to simultaneously do what he had recommended. Also, that as an outcome of the adoption of this plan it had been stated in an official communication by the Inspector-General of Agriculture, that good results had already been accomplished, and every publicity should be given to the fact.* Some account of Dacus Oleæ and its ravages, and a characteristic representation of the insect, will be found in Louis Figuier's popular work on entomology.

The Mango.—In "The Agricultural Pests of India," at page 83, the author, Surgeon-General Edward Balfour, quotes second-hand, on the subject of a mango Fruit Fly—an Indian native newspaper, the *Reis and Rayyot*—as follows:—"The fly is so tenacious of life that it thrives within the heart of the fruit. You cut a fruit apparently sound, without a spot on the surface, when, lo! the fly issues out of the interior and buzzes about you." No device, however, seems to have been adopted, neither does Balfour suggest any, for the purpose of combating this pest, notwithstanding the fact that "these insects have degraded the East Bengal mango for at least more than half a century, and yet no notice has been taken of the matter." Even "the scientific name of the insect is as yet a desideratum."

Guava.—This fruit, at least when grown in the district of Brisbane, is especially subject to the attacks of a fruit fly. We are not in a position to state whether the maggot infesting it is identical or not with that of the Tephritis with which we have been more immediately concerned.

Black Fruit Fly (*Anthomyia*, sp.).

Together with five ordinary Fruit Flies, which were bred from three Toowoomba seedling peaches there occurred seven small dark-coloured glossy flies. In a second instance also a single example was reared from peaches also affected by the Fruit Fly. The Black Fruit Fly is a small dipterous insect, measuring $4\frac{3}{4}$mm. (nearly 3 lines) in length, with a large head, very prominent elevated thorax, and distally depressed abdomen. Colour, dark glossy green, with bronze reflections, appearing nearly black when unexposed to the full light. Body clothed with small black hairs and fewer bristles of same colour. Wings ample, when unexpanded directed backwards, and extending behind the abdomen, overlapping each other, and having their anterior borders parallel with the sides of the body.

This fly is one of the Muscidæ, related to *Anthomyia*, but we are unable to refer it to its proper genus. The following definition of its leading characters may enable its systematic position to be determined:—

Head about twice as broad as long, rounded. Mouth-cavity large, closed by the fleshy proboscis; surface of head on each side of mouth hairy.

* *Op. cit.*, 1852, t. 34, p. 370.

Labium, light-coloured. Palpi, oblong, brown, covered with numerous short and fewer long hairs. Clypeus, broadly triangular. Antennæ, brown, with a long naked distinctly three-articulate bristle at the base, extending outwards. Eyes, large, glabrous, reddish-brown. Front, purplish blue, covered with small blackish hairs. Vertex, with eight black bristles, three directed backwards, arising from behind each eye, and two from between the ocelli. Thorax, clothed with small hairs and stout long bristles, the latter arising especially from the mesothoracic and metathoracic scutellum, this having two bristles at its tip and one on each side. Wings, large, with well developed alulæ. Veins, very light brown. Membrane uncoloured, costal border with small bristles along its entire length, and one larger bristle near its base; remainder of border with very small hairs increasing in length towards and on the alula. Three costal cells, the first basal cell extending as far as union of first longitudinal and costal veins; third posterior cell open behind; costal vein extending to fourth longitudinal; six longitudinal veins, all of which, except the sixth, meet the margin of the wing; the auxiliary and first longitudinal veins unite before reaching the costal margin; the distance between the middle and hind transverse equals that between the shoulder vein and the union of the first longitudinal and costal veins. Legs, dark brown, with the first joint of tarsi light brown, a stout spine from the distal end of the intermediate tibia. Abdomen, as seen above, six-jointed, rounded behind, its extremity covered with numerous, rather long, black hairs; very glossy. Expanse of wings, 8mm. ($\frac{1}{3}$ inch).

The *female* is distinguished from the male by having a pointed instead of rounded abdomen, which terminates in a rather long ovipositor. This tapers, but is very different in shape from that of the Fruit Fly, and its extreme point being obtuse, and armed with four hairs, it is not such a perforating instrument as is the corresponding organ in that insect.

The extent and exact nature of the injury occasioned by these flies is unknown. It was reported during the progress of this inquiry that Mr. Holmes, of Ballard's Camp, had found that a small black fly did him much more damage than did the ordinary fruit fly. On visiting his orchard, however, this fact was not brought under our notice, neither was our attention directed to the existence of these insects. The peaches from which the specimens were derived were fully ripe, and from precautions taken it is not very probable that the eggs were deposited in them immediately after they were taken from the trees, and impossible that they could do so after they came into our hands. The perfect flies hatched out twenty and twenty-one days after the peaches had been gathered.

Remedies.—Remedies can only be of a preventive nature, and are such as generally apply in the case of the Fruit Fly proper. (*See* pp. 65-69.)

YELLOW PEACH MOTH (*Conogethes punctiferalis*, Guenee).*

The pest in this case is the grub (caterpillar) of a small ochreous-yellow moth, which bores into the unripe fruit, and, covering the entrance to its excavation with brown particles of "frass" and web, causes often several young fruits to adhere one to the other, by reason of the presence of this foreign matter, and owing also to gum which exudes as a result of the injury. The nature of the damage occasioned by the Conogethes is thus referred to by Dr. J. Bancroft: "The cater-

* The identification of this moth with the above species as described by M. Guenee in his "*Histoire Naturelle des Deltoides et Pyralites,*" 320, 347, in 1854, is due to Mr. Meyrick, he having named this insect for Dr. T. P. Lucas, of Melbourne, to whom specimens of the Peach Moth were sent by Dr. J. Bancroft in 1886.

pillar when feeding on unripe peaches may be observed to tie several fruits together, making burrows in their substance. The peaches never ripen, do not fall off the branches, but remain hard and dry on the tree for months."*

This pest occasions considerable injury in the Brisbane district, but in Toowoomba, as far as was observed by us, is confined to early peaches, for instance the China Flat, and the black dried up fruit that remains on the tree long after the Conogethes has left, and which indicates the fact that it was once there, also points to this limitation in its occurrence. The following is a description of the insect in its different phases:—

Imago.—Male and female. Yellow ochreous; forewing with transverse purplish-black basal and sub-basal spots, an antemedial row of spots, a post-medial and a discal zigzag series of spots, and three medial sub-marginal spots ; a spot also near end of cell, and a lunule at the end ; hind wing with a purplish-black spot at end of the cell, a discal, and a sub-marginal zigzag series of spots. Thorax black spotted (a central spot on hinder border of prothorax, also in the same position on meso-scutum and in the middle of each partagia.—H.T.). Abdomen with three dorsal rows of black spots (there being three on each of the consecutive segments which bear spots) ; palpi, with a brown or blackish band ; forelegs and tarsi with blackish bands.—*F. Moore.*† Expanse of wings, $\frac{7}{8}$ inch to 1 inch.

The Male.—Both males and females vary somewhat in size, and occasionally a female moth may be even smaller than a male, but the latter is always distinguished by the presence of the black-streaked anal tuft, it being simply ochreous-yellow in the females.

Chrysalis.—Dark reddish-brown ; segments finely rugose with a few minute teeth on anterior border ; length $\frac{1}{2}$-inch.

Caterpillar.—Cylindrical, smooth, with a few erect hairs scattered here and there. General appearance pinkish-red, ground colour dirty white, almost hidden by pinkish-red markings. Head, dark brown, shining. First body segment above (collar) lighter brown with a central white line. Body covered with well defined grey spots or blotches, which are arranged on each side of the centre of the back as follows: 1st, a row formed of two unequal spots on each segment; 2nd, a row formed by a single spot; 3rd, a row below the spiracles formed of two unequal spots ; 4th, a row immediately above origin of limbs of single spots; 5th, a row of small spots anterior to and below the last—confined to the fourth, to the twelfth segments. On the segments not bearing appendages the spots are continued on the under surface of the body, the other segments being immaculate beneath. Nearly all the spots contain hair-bearing black points, one or two on each. Spiracles black. Length, $\frac{13}{16}$ inch.

The egg is laid in or upon the young peach when the latter is but half grown. The caterpillar continues feeding until the fruit has decayed owing to its attacks, and it is probable that when fully matured it usually leaves the peach in order to secure some place suitable for its requirements when in the chrysalis stage, although

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* "An Inquiry into the Maize Disease of the Caboolture District," by J. Bancroft, M.D., Proc. Roy. Soc. Qd., vol. iii., p. 110, Brisbane, 1887.

† "The Lepidoptera of Ceylon," pt. xiii., p. 333. London, 1886.

occasionally it passes into this condition within the peach itself, and this usually happens if the fruit is already dry. The spots selected for pupation on the peach tree are similar to those which the caterpillar of the Codlin moth selects in the case of the apple, and any cranny in the bark chosen for this purpose is, in this case also, frequently gnawn in order to make it especially suitable. The chrysalis is contained in a light cocoon of whitish silk.

There are several broods during the season, and it is a portion of the first brood which attacks the peaches. During the summer months, especially when the early peaches have "gone out," the moth lays its eggs in, or on, the stems of succulent plants, choosing for this purpose, amongst others, the Dahlia plant, but especially the maize (*see* Maize). Our observations would lead us to conclude that the last brood of the season hibernates, in the caterpillar phase, within the food plant on which it subsists. The large pods of a bean, sometimes grown in gardens here, and known by the name of *Canavallia indica*, are especially liable to the attacks of the Conogethes, and it is within these that we have found its caterpillars hibernating. Dr. J. Bancroft informs us that "A single example also was hatched out from caterpillars found feeding on the senna bean, *Phaseolus gladiatus*. Again, we have found the adult caterpillar within the pods of a species of Cassia, at Brisbane, during mid-winter. Also within the stem of millet.

Conogethes punctiferalis has quite an extended range of occurrence; being met with, according to F. Walker, in Hindostan, North China, and Shanghai; to F. Moore in Ceylon, and Meyrick in Australia, as we, too, have found to be the case.

Remedies.—Nothing can be done to save peaches when they are once attacked by this pest. Preventative measures are limited to those which compass the destruction of the insect in its different stages, and then, again, efforts in this direction will be only successful to a very limited extent, seeing that the food plants of the Conogethes are so numerous and variable. The moth, of course, is a night-flying insect; but we are not prepared to say whether or not it is attracted, to any extent, either by light or by "sugar."

Fruit-Eating Caterpillar (Dark-Brown Noctuid).

The specimens of fruit which had been attacked by the caterpillars of this moth were some badly grown examples of the Yellow Munday which had "gummed" very much.

The symptoms presented, taking a typical example of damaged peach as an example, were the following: There were two large holes of irregular form, slightly enlarged beneath the surface—which had been excavated into the flesh to a depth of nearly ½-inch, and between these and the prominent apex of the fruit was a large patch the entire surface of which, with the exception of one small spot where the skin was still remaining, had been gnawed away to a varying depth. Sometimes the injury is confined merely to removing the skin of the fruit. The caterpillars also occasionally consume the leaves of the tree, roundly notching the border.

At what stage in the growth of the peach the attacks of this caterpillar are commenced has not been ascertained, but that they will feed on nearly ripe fruit has been experimentally demonstrated. The

effect of the injury which it occasions, however slight, will tend to spoil the marketable condition of the peach, as there would be no ready sale for peaches, the epiderm of which was gnawed over large areas; moreover these injuries, and especially if the fruit is approaching ripeness, will subsequently determine the commencement of a rapid process of decay.

The following is a description of the insect in its different stages:—

The Caterpillar.—This slightly tapers from the third segment forwards to the extremity of the head, otherwise it is of uniform thickness; there are the full complement of thoracic legs and abdominal and anal prolegs. The segments from 1-9 are corrugated with transverse rugæ. The general colour is a dull, dark brown, with two interrupted fine pale bands above on each side of back. When examined with the lense it will be noticed that the body is finely granulated—the granules being of a dark colour, and that the ground colour is a dirty white, clouded in an indefinite manner with brown showing a slight tinge of red. The segments have also black spots, at most six on each side—two on each segment contributing to form two longitudinal lines along the body between the coloured bands. Most of the spots give rise to short, stout whitish bristles, which cause the caterpillar to appear as if covered with little asperities.* The spiracles and thoracic legs are black. The prolegs are whitish with black patches on the outer surface. The first segment has a central longitudinal white line. The under surface is sooty grey, shaded with pink; mandibles are brown, tipped with a darker shade of the same colour; the labrum is brown, shining, emarginated, and has a few longitudinal grooves. Length of caterpillar reaching to $\frac{3}{4}$ inch.

The Chrysalis.—This measures about $\frac{7}{16}$ inch in length, and is of a rich brown colour. Its segments are slightly punctate; the hindermost segment terminates in two little teeth.

The Imago.—The moth is of a dull brown colour, varied with lighter shades. Forewing elongated triangular, costa arched from the base, apex rounded, exterior margin oblique, dull purplish brown with basal area lighter; with a serrated transverse pale-bordered brown basal, antemedial and a postmedial line. Between the latter two the wing is dark brown, the remaining area being much lighter and only slightly clouded with brown. There are a series of small black spots on the outer border and a single larger one within the cell. Hindwing grey faintly speckled with dusky brown, margin dark with greyish brown cilia; traces of a narrow dark lunate mark in the cell and two obscure transverse discal very pale brown fasciæ, the marks more distinct beneath; on the under surface, also, the apex is clouded with dark brown. Head and thorax purplish brown; body light-brown with ochreous anal-tuft. Maxillary palps distinct, tufted with dark scales; labial palps, long inclined over head and reaching to posterior border of it, dark brown externally freckled with a few light scales; opposing surfaces with ochreous scales. Antennæ moniliform ciliated. Limbs dark brown, freckled with a few light

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* These spots have the following disposition on the middle segments of the body, two dorsal ones on each side of the middle lines, the posterior of which is slightly the more external, one immediately above and another posterior to the spiracle; two inferolateral, the lower of which is the most posterior, and opposite the origin of leg or proleg, when either of these organs is present.

coloured scales the distal ends of joints having a few ochreous scales. Tibial spurs very stout, long, unequal; expanse of wing $1\frac{1}{8}$ in.; length of body $\frac{1}{2}$ in.

Habits.—The caterpillar usually feeds on perfectly sound peaches, although the fact of a fruit, though still of firm consistence, being in process of decay, and covered with mould (Aspergillum), seems to be no obstacle to its attack. When disturbed it falls to the ground, and curling itself up—with the head inwards and the hindermost segment brought over it and touching the first body segment—remains perfectly motionless simulating death, and thus by reason of the possession of this habit and from the fact of its colour harmonising well with that of the ground, it can only with difficulty be observed when in this position. The exact nature of the situation chosen by the caterpillar under natural conditions in which to undergo its metamorphoses is not known, but those kept in confinement spun a cocoon of a very delicate nature, in the walls of which were incorporated small fragments of earth, immediately beneath the fallen fruit, and in this position passed into the chrysalis stage. One exception to this apparent rule was afforded by a specimen which had access to the branch of a peach tree, and this one pupated at the base and on the upper surface of a peach leaf, the cocoon being included in the space intervening between the two inclined sides of the lamina.

Remedies.—The extent to which these caterpillars damage the peach crop is as yet so slight that no special remedies for their extirpation seems demanded. But, where possible, infected fruit should be gathered, both that occurring on the tree and also that which has fallen. It is reasonable, however, to suppose that birds and especially poultry would, in the case of this pest, render great assistance by destroying the caterpillars which usually themselves escape notice.

PEACH WOOD-BORER (*Orthorhinus*, sp.).

Occurrence.—This affection of peach trees has only been observed at Brisbane, where it was first brought under our notice by Dr. Richard Rendle as injuring several trees on Wickham Terrace. As the beetle to whose injuries it is due occurs also in the Toowoomba district, it is thought good to remark on this malady although in a cursory journey through the country, no fruit trees of which it might be certainly said that they were suffering from its attacks were observed.

Symptoms.—On the approach of spring it will be observed that the peach-tree fails to produce any leaves, and it is soon discovered that this is because it is dead. It has not previously shown any noticeable sign of decay. The extreme branchlets are intact and there are no rotten boughs. Neither does it appear to be otherwise unhealthy, but "well grown," with perfectly clean bark. Possibly a few minute punctures may be noticed on close examination, but often not these. If the tree is now left standing, holes, which may have a circumference of quarter of an inch appear later on. The wood, however, of the tree will at the first evince extensive injury, and that occurs throughout its entire substance—just under the bark as well as in its very centre. Channels course through it, running for the most part in a longitudinal direction, but not necessarily straight. They may also be obliquely directed across the wood. It not infrequently happens that two or more of these channels pass side by side, or run

into one another. They are circular in section and have a diameter of from 2 mm. ($\frac{1}{12}$ inch) to 6 mm. ($\frac{1}{4}$ inch) or more. On tracing some of the smallest of these excavations it will be found that they are connected with the exterior by small orifices. These channels are all quite filled, except where the insects in their different stages occur, by fine wood debris compacted into a hard mass. At the ends of the extensive tunnellings will be found sluggish white grubs. These are the larvæ. In portions of the channels nearer the surface, usually at right angles to it, will be noticed (1) the inert white naked nymph, or even (2) the adult beetle.

The following is a description of this pest:—

The adult is a beetle of the weevil family; that is, one in which the head is produced into a snout of greater or less length, at the extremity of which is situated the small mouth, and on whose sides repose the antennæ or feelers—folded in a groove. They have also their elytræ or wing-covers of a hard consistence usually more or less conspicuously embossed or sculptured, oblong, cylindrical, black, tuberculate, clothed both above and below with light brown scales. A few small patches of white scales on the upper and solitary ones here and there on lower surface. Rostrum straight—rather stout, rugose-punctate about equal in length to prothorax, clothed with tawny and a few white scales. Frons smooth, covered with tawny scales, which tend to form two longitudinal bands opposite prothoracic fascicles. Antennæ springing from near extremity of snout, clothed with linear scales; basal joint of funicle rather exceeding two following joints. Prothorax rounded at sides, rather constricted, anteriorly armed with large, low round naked granules, with two fascicles of tawny bristles on anterior border. Elytra, with ten longitudinal ridges, armed with sharp tubercles, some of which bear apical setæ, alternate with lower similarly-armed ones. Basal tuberosity obsolete; median and that near the apex of each elytron conspicuous, and bearing a fascicle of white and nearly black bristles. Limbs clothed with light chestnut and a few solitary white and more elongated scales, a patch of which scales occur about femoral spines of third pair. Femoral spines low and blunt. First and second tarsal joints about equal; first about as broad as long. Brush of third joint yellowish grey. Length, 8 mm. ($\frac{1}{3}$ inch). Greatest width, 3 mm. ($1\frac{1}{2}$ lines).

The description of this beetle, when compared with that of O. Klugii, Schönherr*, will suggest some affinity between these species, but Schönherr's characterisation of the elytra of O. Klugii as "finely striate-punctate" does not apply to the insect before us, neither is there in it "a patch (of scales) in front of the scutellum of a reddish brown." The males of O. cylindrirostris, too, do somewhat resemble it, but these have longer, slenderer, and more finely sculptured rostra, the antenna in it arises further back, and the length of the first joint of the funicle is also relatively longer.

The *Larva*.—This is a whitish coloured, curved thick grub, measuring nearly half an inch in length when fully grown and extended. (The male in its larval condition is probably of less length.) The head is white with brownish clypeus and brownish-black mouth organs. The body is of about equal breadth, and slopes downwards

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* Curculionidæ, vol. 3, p. 246, quoted by W. Macleay. Proc. Lin. Soc., New South Wales, Sydney, 1883, vol. vii., p. 345.

towards the blunt unarmed extremity; it is crossed by numerous wrinkles, those in the posterior extremity being little defined. It is quite footless, three pairs of swellings on the under surface replacing the feet. When removed from the wood the grub is found to be partly rolled up, the hind segments of the body being so bent that the head and tail are brought nearly into juxtaposition.

The *Pupa.*—In the pupa may be recognised the snout bent under, and placed against the head and thorax, and the limbs also folded up. On the upper surface the segments are all exposed and well defined, the rudimentary widely separated, elytra and wings being folded, and passing between the second and third pair of limbs to the under surface of the body. The terminal segment of the body bears at its extremity two small widely separated blunt spines. All the abdominal segments on their posterior border have a few dark-coloured hairs. Length from $\frac{2}{5}$ to $\frac{3}{5}$ inch according to sex.

Life History.—There is reason to suppose that not less than twelve months elapse between the time when the egg of the Orthorhinus is deposited in the tree and the development of this into a full-grown beetle. These insects, though rarely met with in October, are about during the hottest months of the summer, and it is during the autumn and winter that the larvæ feed. It is owing to this fact, viz., that the destruction of the tree is being effected whilst the leaves are off, that their work cannot be noticed until the tree in which they have taken up their abode is beyond recovery.

Habits of allied species.—The comparison of the habits of the Orthorhinus before us with those of O. Klugii and O. cylindrirostris is very interesting. Concerning the former the Hon. A. C. Macleay remarks*:—"At the last meeting of this society I exhibited some coleopterous larvæ which had been found by Mr. Holroyd to have committed very serious havoc amongst his grape vines. I also exhibited cuttings of the injured plants showing the pith or centre of the branch completely eaten away along the entire length of the season's wood, with, in some cases, the devastation extending into the old wood and the roots."† We have to add in reference to the latter O. cylindrirostris, Fab., that its larva is equally destructive to our native vegetation. We have found the otherwise very serviceable timber of the scrub-tree Syphnodon bored through and through by it. When adult this beetle may be found during the summer months attached to the extremities of the branchlets of the shea-oak (Grevillea robusta) and observed to be gnawing through the bark at the base of the young leaves, and inflicting injuries which are displayed as ugly scars, which are seen to cover the bark, as the branchlet lengthens out; also on the vine and the loquat.

Again, Mr. Walter Hill, of Eight-Mile Plains, near Brisbane, has forwarded a closely allied species of Orthorhinus, which he observed eating, in patches, the green bark of the young wood of the orange.

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* Proc. Lin. Soc., N.S. Wales, vol. vii., p. 344.

† The same insect or one congeneric with it, when in its adult state, is known to injure the grape vine at Brisbane. Its mode of procedure is a little curious. Just prior to the berries turning, or even when they are getting fully ripe, the Orthorhinus settles on the foot-stalk of the bunch and gnaws the surface of it and into the subjacent tissue until it is completely "ring-barked." The nutriment which the ripening bunch should receive is thus intercepted and as a consequence the grapes wither and dry up.

Distribution of Orthorhinus.—There are about two dozen species belonging to this genus. These are met with from Tasmania to New Guinea and in some of the islands of the Pacific. Australia is, however, their head centre, they not having been found in Europe, Asia, or America.

Remedies.—After a tree is once infested with these borers the sooner it is rooted up and destroyed the better, and this should be done in the spring before any of the adult insects have had time to emerge and insert their eggs in the wood of trees which may have hitherto escaped their attacks. There may be reason in some cases to anticipate the attacks of these beetles, and the grower will then have to consider whether the tree, or trees, are of such value as to permit of his adopting, without monetary loss, some preventive measure. He might, after having well scraped the outer bark with a wire brush, thoroughly impregnate its surface with a strong solution of camphor in spirits of wine. A brush also might be used for the latter operation. This use of camphor in preserving trees from the attacks of boring insects has been highly extolled by E. Bobert some twenty years since.*

FRUIT WEEVIL (*Brachypeplus,* sp.).

Description.—This is a small flattish finely pubescent beetle having its wing-covers, but partly concealing the abdominal segments. It measures about $\frac{1}{6}$ inch in length, is of a general testaceous brown colour, with the thorax beneath and the base and apex of the wing-covers dark brown, and the centre of the latter organs golden yellow. It belongs to the family Nitidulariæ, and to the genus Brachypeplus.†

Habits.—In the case of peaches, and other stone fruit, this beetle enlarges the minutest punctures of other insects, and so finds its way to the succulent flesh on which it proceeds to feed. Its attack is especially made when the fruit is ripening, a process which its injuries unduly hasten prior to their determining the presence of decay. The "weevil" most frequently works in conjunction with the "fruit fly." From small holes in an infected peach the little beetles may be seen to emerge one by one as the fruit is handled. The Brachypeplus deposits its eggs in the fruit, and its larvæ feed upon the latter until they have arrived at an advanced stage of growth. They then enter the ground, and just beneath its surface form small smooth-lined cavities in which they pass into the nymph, and so on into the beetle phase. Several of these oblong chambers occur frequently in one spot, when they may be nearly contiguous.

Almost every fruit grown at Toowoomba is liable to the onslaught of this beetle, and especially so the mulberry and the grape.

It is also injurious to growing maize, usually effecting an entrance into the cob when the "silk" has already been gnawn off by caterpillars.

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* Bull. Soc. Ent., France, 1868, p. xcv.

† Notwithstanding a very detailed examination, it has been found impossible to assign to this species of Brachypeplus its position amongst its congeners, as distributed by A. Murray (*vid.* "Monograph of the family Nitidulariæ," Trans. Lin. Soc. Lond., vol. xxiv., 1864). It is interesting, however, to point out that amongst the species included in the genus is one, B. orientalis, *Murray*, which must have somewhat similar habits, and concerning which it is related that it was found by Mr. Wallace in the fruit of the Durian, at Sarawate in Borneo.

Remedies.—We can only suggest: (1) the immediate removal from the orchard of all fallen fruit, whether decayed or not, and its destruction as soon as possible afterwards, for by such means large numbers of insects will be destroyed; and (2) that no fruit be left upon the trees after it has become fully matured. Most of the measures, too, already suggested in the case of the Fruit Fly will also be found useful when contending with the Fruit Weevil.

Peach Aphis.

Of the Aphides reported as being so destructive to peaches in the southern colonies, Toowoomba, has at least the black variety. This is usually most prevalent in the spring of the year, or rather, perhaps is more noticeable then than later on, when the foliage is more developed.

Injury Occasioned.—It limits its attacks to the young shoots, and as a result of the injury which it occasions—by inserting its rostrum into the tissue of the plant, the leaves become imperfectly grown, and the secondary shoots, arising from the axils of these, are stunted instead of being lengthened out. The green epidermis of the skin in patches, too, becomes thickened and of a red colour. Thus it hinders the wood, which is to perform such important functions in the ensuing spring, from becoming developed. The occurrence of this pest at Toowoomba and at Brisbane may suggest the possibility of its becoming as destructive to the peach tree here as it has proved itself to be in other colonies, as we see from the following testimonies:—Mr. W. C. Williams, Forester in charge of the North-eastern District of Victoria, in giving evidence before the Royal Commission on Vegetable Products, stated that about eleven years ago the peach trees were so prolific in his district that people fed pigs on their fruit, whilst now, owing to the occurrence of blight (aphis) amongst them, there was "not a peach in the district except where a stone had fallen."*

Again, Mr. George Neilson, Curator of the Royal Horticultural Society's Gardens, Melbourne, during his examination before the same committee, stated that it had been a difficulty for the last twenty years to cultivate the peach at all in some districts of Victoria on account of "this pest of the aphis," and he added: "It is attacked by two; the black one is the present scourge. Immediately we get rid of the black one, we have the green one, which is ten times worse. . . . It destroys the flowers, and consequently the fruit."†

Description.—The peach aphis generally resembles that of the plum (*see* "Plum"), although it measures somewhat less than does that insect. In both, the adult viviparous females are of a dark brown—almost black—colour, and glossy. The young insects are very light yellowish-brown, with the eyes and nectaries black, and therefore well defined. The swellings which mark the site whence spring the organs of flight in the viviparous winged females are of a light green tint.

Remedies.—Balfour states that "Aphides are readily destroyed by water charged with metallic iron."‡ Unfortunately, however, he does not give any directions for preparing so useful a fluid, nor is it

* "Royal Commission on Vegetable Products." Third progress report, page 106. Victoria, Nov., 1886.

† *Op. cit.*, p. 121.

‡ "The Agricultural Pests of India," p. 24. London, 1887.

clear what is the meaning of such a curious assertion. Professor C. V. Riley, referring to remedies available in contending with the cabbage aphis, and therefore useful in destroying other aphides as well, states as follows : —" The remedy of fumigation with tobacco smoke, as recommended by Fitch, Curtis, Thomas, and others is impracticable on a large scale, and applications of soot, ashes, lime, and washes of tobacco-water and other materials seem ineffectual. Strong *Whale Oil Soap Solution*, indeed, seems to be the only remedy so far tried which affords any satisfaction. This is highly recommended by Professor W. R. Lazenby, formerly of the Horticultural Department of Cornell University. Taschenberg (Naturges. d. wirbellosen Thiere), recommends sprinkling with soapsuds treated with *Quassia*, and also the use of a decoction of fresh *Walnut Leaves.* Here again the *Pyrethrum infusion* will destroy a large number of the insects which work in such exposed situations that they can be easily reached by a spray. (*Vid.* Appendix), but the *Kerosene Emulsion* will prove more satisfactory than any of the other insecticides mentioned."*

NOTE.—We may appropriately include here the following information relating to the preparation of the *Kerosene Emulsion* as given by Hubbard in the *American Entomologist*,† premising that this is the formula which he found—after repeated experiment—was most satisfactory for the purpose—viz., kerosene, 2 gallons, or 67 per cent.; common soap or whale-oil soap, ½ pound ; water, 1 gallon—these two last substances amounting to 33 per cent. " Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force-pump with spray nozzle (*i.e.*, garden syringe) for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. The above formula gives 3 gallons of emulsion, and makes, when diluted, 30 gallons of wash. The kerosene and soap mixture, especially when the latter is warmed, forms upon very moderate agitation, an apparent union, but the mixture is not stable and separates on standing or when cooled, or diluted by the addition of water. A proper emulsion is obtained only on violent agitation. It is formed not gradually but suddenly—in short, to use a familiar phrase, 'it comes like butter.' The time required in churning depends somewhat upon the violence of the agitation, but still more upon the temperature, which need not be above blood heat."‡ In making the emulsion, *milk* may be substituted for the soap. Dr. M. S. Barnard, an assistant to Prof. Riley, states on this subject that, "An emulsion resembling butter can be produced in a few minutes by churning with a force pump, 2 pints of kerosene and 1 pint of sour milk in a pail.

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* "Report of the Entomologist," Department of Agriculture, U.S.A., Washington, 1884, p. 319 ; quoted also in *Gardener's Chronicle*, June 6, 1885.

† Mr. A. F. Spawn has stated, on November 17, 1886, that "fruit growers came to the conclusion, at the last convention of the California Fruit Growers' Association, held two years previously, that I attended, that it was useless to make any *mixture* with kerosene oil to overcome the difficulty of insect pests, and they recommended it to be abandoned entirely." Royal Commission on Vegetable Products, Fourth Progress Report, Victoria, 1887, p. 11. We have italicised the word "mixture," since failure may have resulted from the kerosene not being properly emulsified, a condition on which the advocates of kerosene emulsion lay the utmost stress.

‡ *Gardener's Chronicle*, June 20, 1885, p. 786.

Liquids being about blood heat. Dilute 12 parts of water to 1 part of emulsion."* These fluids, of course, must be distributed by means of a spray or cyclone nozzle.† (*Vid.* Appendix.) [Kerosene oil alone, or when applied in an unemulsified condition, will kill most trees.]

Rate of Increase.—During this inquiry the question has been often asked as to where Aphides have come from, which have apparently suddenly appeared in large numbers in comparatively isolated spots. In the first place, the means possible whereby a single aphis, capable of producing its kind, can be conveyed from one plant to another growing even at some remote spot, are numerous enough. Then all that is required is the inherent prolific capabilities of the aphis itself, due regard being taken of the fact that this insect produces its kind for the most part agamogenetically. The following particulars will explain these statements :—" In the Aphides, ova deposited by the impregnated females in the autumn are hatched in the spring, and give rise to forms which are very generally wingless, and bring forth living young. These may be either winged or wingless, and are also viviparous. The number of successive viviparous broods thus produced has no certain limit; but, so far as our present knowledge goes, is controlled only by temperature and by the supply of food. Aphides kept in a warm room and well supplied with nourishment have continued to propagate for four years." ‡ The rapidity with which generation succeeds generation may be inferred from the fact that on examining a viviparous female not only can one see within it the young unborn insects, but even within the latter themselves the members of a succeeding generation.

The simple statement of the few experiments which Charles Bonnet (" *Traité d'Insectologie ; ou, Observations sur les Pucerons*," pp. 28–38, 1re Partie, 18 mo, Paris, 1745), made " has sufficed," as Louis Figuier remarks, " To show how rapid is the multiplication of Aphides." A single female produces generally 90 young ones ; at the second generation these 90 produce 8,100 ; these give a third generation which amounts to 729,000 insects ; these in their turn become 65,610,000 ; the fifth generation, consisting of 590,490,000, will yield a progeny of 53,142,100,000 ; at the seventh we shall thus have 4,782,789,000,000; and the eighth will give 441,461,010,000,000. This immense number increases innumerably when there are eleven generations in the space of the year. Fortunately a great many

* *Gardener's Chronicle*, June 27, 1885, p. 813.

† *Kerosene Emulsions.*—Failure in forming a stable emulsion is due, in most cases, to insufficient agitation of the mixture. The emulsion can be very quickly and easily made by using a good force-pump, so constructed that it can be inserted directly into the liquid, which must be kept in a constant and violent agitation by forcing it through some form of spray nozzle (*vide* Appendix) back into the same receptacle. A pump otherwise good is less adapted to forming an emulsion if, instead of being inserted directly into the pail, it has a large and long supply tube, in passing through which the liquids are comparatively quiescent and consequently have a tendency to separate. Another frequent cause of failure is the attempt to form an emulsion by churning together a small quantity of kerosene and a large quantity of diluent. Only a very unstable union can be effected by this means. The very essence of the process requires that the oil shall be broken down by driving into union with it a smaller, or at most an equal, quantity of the emulsifying solution, after which, if a genuine emulsion is formed, it may be diluted *ad libitum* with water.—*C. V. Riley*, United States Entomologist.

‡ Huxley, " On the Agamic Reproduction and Morphology of Aphis." *Trans. Lin. Soc., Lond.*, 1857, quoted in "The Anatomy of Invertebrated Animals," p. 447.

carnivorous insects wage fierce war against the plant lice and destroy immense numbers of them."* On the setting in of cold weather, or apparently on the failure of nourishment alone, in some cases males and females are produced by viviparous forms (Huxley). These lay eggs or not; for, as Lichtenstein has remarked, there are two groups of Aphides, one annual, passing the winter in the egg state, and the other perennial, lying torpid through the winter, and capable of resisting any amount of cold; but the first class is by far the most numerous.†

Relation of Ants to Aphides.—A witness during his examination by the members of the Royal Commission on Vegetable Products, Victoria, on being asked the question, "Do you think that ants have anything to do with it?" (*i.e.*—an injury which the peach trees were suffering from, and which had been attributed to the attacks of aphides), replied, "I wish I had a few broods more. Ants are mere scavengers;" and again, on being asked, "Do you think the ants have anything to do with bringing the aphis?" stated "No; they destroy the Aphis."‡ From this we may conclude that some importance is attached to the relation which subsists between Ants and Aphides, and that very erroneous opinions are disseminated concerning this subject. The former of these conclusions might also have been arrived at from the consideration that the so-called Black Aphis of the peach, with which we are now immediately concerned, is, whilst it lives on the young shoot of that plant, as we have often observed at Brisbane, constantly accompanied both night and day by a very small dark-coloured, active, stinging ant—a species of *Lasius*. We will, therefore, briefly state what is the actual nature of this relation. Aphides habitually discharge, as a residuum of undigested food, through their anal apertures, a sweet fluid, popularly known as "honey-dew." Ants, as well as some other insects, are very fond of this, some species almost entirely subsisting upon it; and this food material is obtained by them from the surface of the leaves on which it naturally occurs, or, in other cases, the aphides are provoked to discharge it by ants which attend them, and which in order to promote this action stroke these plant-lice with their antennæ.§ From this habit has arisen an interdependance between these insects, for the ants never destroy the aphides, but protect them from the attacks of numerous aphis-eating insects and also from the visitations of other ants; the latter not only belonging to species differing from that one which they themselves typify, but also being such as are of the same species but members of other ant communities; and this protection is even carried to the extent of erecting covered ways under which the aphides may progress and feed.|| The solicitude which the ants exercise over the aphides extends, too, still further. One phase in the life history of many aphides is passed beneath the surface of the ground, and during its existence those insects are beholden to the roots of plants—not necessarily to those of the one on which they have been previously feeding—for sustenance. Now, M. Lichtenstein, of Montpellier, has observed with reference to an aphis, Shizoneura venusta (*Passerini*), that it

* *The Insect World*, p. 122.

† *Vid.* "Comptes Rendus, 1880," xc., pp. 80 and 81.

‡ *Vid.* Third Progress Report, 1886, p. 122.

§ *Cf.* Huber, "Les Fourmis Indigenes," Genève, 1861, p. 162.

|| *Cf.* Huber, *Op cit.*, p. 172.

arrives—from whence he was unable to state—at the collar of the root of two species of Setaria, and that there, feeble and incapable of undertaking a subterranean journey, it awaits the advent of some friend which will enable it to attain the roots of these grasses, on which it is to deposit its progeny. It does not wait long; the first ant which passes stops, examines the plant-louse and runs off to tell its companions of what it has found. Quickly about half-a-dozen ants arrive and commence to tear off the wings of the Aphid, to which operation it offers no resistance; whilst at the same time they excavate with unusual rapidity, as an easy approach, a small tunnel into which the Schizoneura enters, and this conducts it straight to a root of the Setaria, on which it fixes. About it a small recess is then made by these intelligent protectors which sedulously surround the insect, whilst they themselves are recompensed by the sweet juice with which it and its progeny furnishes them. All the aphides in this phase have the wings torn off. . . . But, if the plant-lice on arrival at the roots are powerfully assisted by the ants to the detriment of their wings, in the next phase of their existence, when they abandon the roots and disport themselves on the branches of trees, they are much more so, for when then these subterranean aphides, preparatory to this mode of life, take on their wings, the ants open out for them a way by means of which they can gain the exterior.*

These observations of Lichtenstein received confirmation from what Sir J. Lubbock noticed independently in England. Within an ant's nest, which he was preserving for the purpose of studying the inmates which it contained, he found some eggs which he proved to be those of aphides. These eggs the ants treated "exactly as if they were their own, guarding and tending them with the utmost care," and when brought near an ants' nest they were carried inside and afterwards hatched into young plant-lice. Concerning them this eminent observer remarks, "When my eggs hatched I naturally thought that the Aphides belonged to one of the species usually found on the roots of plants in the nests of *Lasius flavus*. To my surprise, however, the young creatures made the best of their way out of the nest, and indeed were sometimes brought out by the ants themselves. In vain I tried them with roots of grass, &c.; they wandered uneasily about and eventually died. Moreover they did not in any way resemble the subterranean species. In 1878 I again attempted to rear these young Aphides; but though I hatched a great many eggs, I did not succeed. This year, however, I have been more fortunate. The eggs commenced to hatch the first week in March. Near one of my nests of *Lasius flavus*, in which I had placed some of the eggs in question, was a glass containing living specimens of several species of plants commonly found on or around ants' nests. To these some of the young Aphides were brought by the ants. Shortly afterwards I observed on a plant of daisy, in the axils of the leaves, some small Aphides, very much resembling those from the nest, though we had not actually traced them continuously. They seemed thriving, and remained stationary on the daisy. Moreover, whether they had sprung from the black eggs or not the ants evidently valued them, for they built up a wall of earth round and over them. So things

* Annales de la Société Entomologique de France, 5 serie, tôme x., 1880 Bulletin, p. ciii. *Trans.*

remained throughout the summer; but on the 9th October I found that the Aphides had laid some eggs exactly resembling those found in the ants' nests; and on examining daisy plants from outside, I found on many of them similar Aphides, and more or less of the same eggs . . . . Our ants may not perhaps lay up food for the winter,* but they do more, for they keep during six months the eggs which will enable them to procure food during the following summer."†

SCALE INSECTS.

(1) Black Scale (*Lecanium oleæ*).

This pest is occasionally met with on the peach tree at Toowoomba, and two instances of its occurrence came under our notice—one in Mr. Gregory's garden near Paradise Estate, and another along the road which extends from Mount Pleasant to Mr. C. Hartmann's nursery. As in the case of other trees this Lecanium is accompanied on the peach tree also, by a conspicuous development of sooty matter or "fumagine."

Description.—(*Vid.* "Scale Insects on Orange—Black Scale," p. 124).

Remedies.—There can be no doubt that if this scale insect developed extensively a taste for the peach it would become very destructive indeed. In the case of isolated trees subject to its attack the better method would be to eradicate and burn them; failing this those means should be resorted to which are recommended in referring to its occurrence on the orange (*vid.* "Black Scale—Orange").

Note.—As the reader may not be in possession of one or other of the few works which deal with the Coccidæ, the consideration of the following facts concerning them may lead to the better comprehension of their habits and nature. This family Coccidæ is a division of the order of insects known as Homoptera, an order which contains the Cicadas, the Leaf Hoppers, and the Aphides or Plant Lice. It includes the Scale Insects proper, the Mealy Bugs and some other of their allies, and there is therefore a great variety of form displayed in the different insects comprised in the family. Even individually the variations in these insects at different stages of their existence are equal to those which in other insects would serve to characterise distinct families. They may, however, be said to have this in common—viz., the wingless condition of the females, and in the males the wings reduced to a single pair, the hind ones being represented by hair-bearing balancers, and the absence of organs with which to procure food.

This variety of form, however, enables the Coccidæ to be classed in several well-marked sub-families, of which the following will come under our consideration.

The *Diaspidinæ*, which are Coccidæ covered by a scale composed in part of molted skins, and in part of a distinct secretion of the insect.

The *Lecanidinæ*.—Coccidæ, either naked or enclosed in shields of secretion, or simply covered with waxy calcareous or filamentary material; most of the females after impregnation taking on a different form, and once fixed remaining so for the rest of their lives, although while growing they retain the power of moving under certain circumstances. Lower lip 1-jointed; extremity simply divided; anal plates present.

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* Of course, this remark does not apply, as we have elsewhere shown, to Australian Formicidæ.

† "Observations on Ants, Bees, and Wasps." Journ. Linn. Soc., Lond., vol. xv., No. 83, pp. 182-4. June 17, 1880.

Coccidinæ.—Females keeping the form of the body with segments distinct and retaining through life the power of motion. Naked or covered more or less with a waxy whitish excretion, filamentary or more or less spumous. Lower lip many-jointed, and extremity divided into two lobes, each furnished with a long bristle; no anal lobes.

The following description of the changes undergone by the Red Orange Scale (*Aspidiotus coccineus*) may serve to illustrate the character of the metamorphoses of these insects, though even they are subject to much variation. In this Aspidiotus the newly hatched scale insect is oval in outline, much flattened, furnished with six legs, a pair of antennæ, and an apparatus for sucking the juices of plants. It is at this time but a mere speck but very active, and, with the aid of a lense, may be detected crawling over the leaves or bark of an infested tree. After a few hours the young scale insect settles stationary in one place, and from its body there exude threads of wax until the whole insect is completely covered with a cottony investment. This may be in a day, or may even take six for its accomplishment. The mass of fibres thus formed gets blown away by the wind and the young scale meanwhile secretes a pellicle or body skin which is shed when the bark louse is generally, in the case of the female, about one-third of the age at which it is sufficiently developed to lay eggs, and in that of the male at about half of the time intervening between the hatching of the egg and the emergence of the winged insect. At the time of this first molt the scale insect undergoes important changes. With this skin are shed both the legs and the antennæ, the Aspidiotus thus becoming a degraded grub-like creature with no organs of locomotion. The mouth, however, is still in a highly developed state. It is terminated by a thread-like organ, which is frequently much longer than the body of the insect, and is composed of four delicate hair-like bristles. By means of this organ the insect is firmly attached to the plant and draws its nourishment therefrom. Up to this stage the development of the sexes is identical. They then both again change their skins. This second and last molt of the female takes place when she is about twice as old as when the first molt occurred. The second cast skin is joined to the first, and with it forms a part of the scale which covers the body of the insect. These two skins, however, form but a small part of the scale which is composed for the greater part of material excreted subsequent to the second molt. The second molt of the male takes place at the same time as that of the female, but in its case after the skin is shed it appears as a pupa and so differs greatly from the female. From this pupa, in a few days only, there emerges a winged insect, which is competent to perform the office of impregnation, for shortly after this last event the female commences to increase in size and becomes distended with eggs. These eggs are gradually deposited, and remain between the insect and the bark of the tree on which it is fixed.* Meanwhile the insect itself diminishes in size until it is quite shrivelled up and the scale itself is filled with eggs, which are the dust-like matter observed in removing an adult scale from the tree to which it is affixed.†

WHITE SCALE (*Diaspis Amygdali*, sp. nov.).

Although this scale was not met with at Toowoomba, it is not improbable that it will be found there, sooner or later, since its existence at Brisbane is beyond all question. We have observed it, too, at Sydney.

At first its presence is betrayed by small white spots or patches on the bark of the smaller branches; but as the insect increases these soon

* In the case of many Coccidæ, however, the male insect never having been observed, the eggs or young, as the case may be, are produced parthenogenetically through many generations.

† This account of the metamorphosis of Aspidiotus coccineus is, in a condensed form, that given by Comstock in his elaborate paper on Scale Insects, contained in the report of the United States Entomologist for 1880.

become in many places confluent, and the individual scales overlap one another, are contorted by being squeezed closely together, or even appear to lie one over the other.* As it will occur quite up to the tips of the branches, the complete destruction of any tree subjected to the attack of the peach scale, and owing to it, is only a matter of time. When already in patches on the branchlets prior to the formation of leaves and fruit, in early spring, it does not hinder their formation; the leaves are green as usual, the fruit sets, but is soon retarded in its growth and shrivels up.

The following is a description of this insect:—

Female scale.—The scale of the female is snowy white in colour with the exuviæ (skins thrown off at the first and second moulting) brownish yellow. It is convex or very much swollen, broadly ovate in shape, and of a delicate texture. The highest point underlying the exuviæ is towards one side, so that these often appear to be lateral. The sides of the scale are somewhat compressed, but there are no signs of the existence of a central keel. Length about 2 mm. ($\frac{1}{12}$ inches).

Female.—The body of the female is of an orange red colour, about $\frac{1}{25}$ inch in length—average length of four specimens, ·0039375 inch. The last segment presents the following characters:—There are five groups of *spinnerets.* These are very distinct, and of them the anterior lateral is more elongated in shape than the other groups, being anteriorly drawn out. The central group contains from nine to sixteen spinnerets, or an average of thirteen in five individuals; the anterior laterals from twenty to thirty-two, or an average of twenty-seven in six individuals; the posterior laterals from twenty-two to thirty-two, or an average of twenty-eight in seven individuals. There are three pairs of *lobes.* These are plain and non-striated. The median pair are truncated or very obtuse at the tips, and have crenated or coarsely-toothed boders; their inner edges are somewhat excavated. They are not approximated at the base, or meet at a very open angle, the intervening space thus formed containing two small spines. The second lobe on each side is lanceolate—obtuse and incised, the anterior lobules being by far the smaller. The third lobe is also deeply incised, but the obtuse wedge-shaped lobules are sub-equal. Beyond the third lobe on either side, and between it and the penultimate body-segment, are two groups of smaller irregularly sized chitinous teeth, each consisting of about five members.

The *Plates* are simple and spiniform (the tips of the dorsal and ventral plates being often directed differently, sometimes give the appearance of a single distally branched plate), two—a ventral and a dorsal one—arising from the anterior side of the base of each lobe, two—also dorsal and ventral—occurring halfway between the meson and penultimate segment, and four or five nearer it. The dorsal and ventral spines are usually of similar shape.

Scale of Male.—The scale of the male is very small, elongated, narrow, of nearly equal breadth—being just three times as long as broad. The exact measurements are—length, ·04875″; breadth, ·01625″. It is very obscurely carinated, the carinæ being obliterated with age. The larval skin is brownish yellow, remainder of scale snowy white.

* Some of these spots present a more finely chaffy appearance—this is where the male scale insects occur crowded together.

Male.—Not seen.

Larvæ.—The young larvæ, of little more than $\frac{1}{100}$ inch in length, are of a light pink colour. They hatch from the eggs whilst still beneath the parent scale, they extend beyond it in every direction, and, taking up their position side by side, completely cover the surface of the bark. They very soon, usually after a few hours, form scales of their own, and, though still able to move about, are completely covered. At this time they may be easily blown from their attachment, and so get from one branch on to another, and, perhaps, from tree to tree. After a few more hours they emit from the surfaces of their scales each a few relatively stout fibres, which curl up. The colony is thus covered by a loose investment, which, whilst protecting the young scales from insect enemies, serves further to aid in their dissemination—for these curled hairs readily adhere to other insects' legs.

Natural Increase.—Our observation has not been sufficiently extended to enable us to record the average time which elapses between the birth of an individual peach-scale insect and the deposition of its eggs, and so we cannot state the number of broods in a year. It would seem, however, that these succeed one another with rapidity throughout the summer months, but that especially in the Brisbane latitude there is little or no increase during the winter months, for in August we were not able to detect a single young peach-scale. Their individual powers of procreation may be judged from the fact that forty-nine eggs were counted within the body of a single insect.

Natural Enemies.—That the peach scale is greatly kept under by natural enemies may be gathered from the fact that in some instances we have noticed that quite 80 per cent. have small round holes in their coverings, an unmistakable sign that they have been subject to the attacks of hymenopterous parasites.

Remedies.—In adopting any remedy it must borne in mind that the insect and its eggs are protected by a hard shield or scale which is impervious to most fluid substances, and not acted upon by washes made solely from alkalies or such other bodies—in solution—the use of which would not of themselves destroy the tree at the same time with the insects. Kerosene, however, by reason of its penetrating power can reach this scale, but this fluid when used by itself will, under many circumstances, kill the tree. It should therefore be diluted. This is done by emulsifying it (*vide* p. 84) with soap solution or milk. The emulsion thus obtained must be used with the ordinary precautions (*vide* p. 84) and applied, either by means of a brush or spray producer (*vide* Appendix) to every portion of the peach tree affected. The best season for its application is winter, or when the leaves are off the tree, at which time also the insects are inflated with eggs. Opportunities, too, for using it should be sought when there is little likelihood of rain occurring to immediately wash it off, or when the sun is not so bright as to cause the kerosene in the emulsion to injure the tree. In order to diminish the cost of treatment and to facilitate operations generally, it were advisable to prune the tree as a preliminary measure—the clippings being destroyed by fire.—(*Vide* also "Use of Resin Compound," p 40.)

It is for the consideration of the fruit-grower to decide whether he would not under some circumstances be justified in at once rooting up an affected tree and afterwards destroying the scale together with it,

which he will be influenced in doing by the fact that the peach is a rapid grower and comes also early into bearing. The general adoption, however, of this extreme measure should alone be decided after consideration of the age of the tree which is attacked ; the extent to which the pest is present ; and the specific value of the fruit which it is in the habit of yielding, and the facility or otherwise with which it can be replaced by an equally valuable tree.

Other Peach Scales.—As far as observations have been carried, this Diaspis confines its depredations to peach trees. Mr. W. M. Maskell ("Scale Insects." Wellington, 1887, p. 52) mentions the fact of the peach tree in New Zealand being attacked by the common apple scale Mytilaspis pomorum, a very different insect, and Professor T. Kirk ("Fruit Blights and Diseases of Fruit Trees." Reprint Brisbane, 1886, p. 41) who had previously made the same observation regarding it, adds, "In Auckland the native sandalwood scale is attacking the peach amongst other fruit trees." We are not aware that any scale insects other than these have been anywhere noticed as occurring on the peach tree, nor that the fact of a scale insect attacking the peach in Australia has been previously recorded.

We have compared this peach Diaspis with the common rose scale Diaspis Rosæ (Sandberg), with Diaspis Boisduvali (Signoret), and with the description* of Chionaspis furfaceus (Fitch), from all of which, though allied to the last mentioned, it abundantly differs.

The Bryobia Mite.

Those leaves of the peach tree† which are spotted by the Uromyces fungus, and less frequently those which are not affected in this way, are infested with numerous small scarlet mites of far smaller size than are the Tetranychus mites (red spider). These are most commonly found congregated on or around the small clusters of fungus on the under surface of the leaves. These minute acari are scarcely visible to the naked eye, and would escape observation were it not for the conspicuous colour of the adults. They are found on the leaves in all their different stages, viz., eggs, six-legged larvæ and eight-legged adults. Like the red spider, they live at the expense of the sap in the leaves, which they imbibe with their snouts, directly from its tissue, or indirectly from the parasitic Uromyces which have previously been developed at its expense. These acari belong to the second section of the Trombidiinæ and to Koch's genus Bryobia. The following are the characters which they exhibit when adult:—

Description.—Viewed from above, their snouts appear triangular. On either side of the mouth beneath is a stout three-jointed palp, ending in a minute pincer-like organ. The second joint of this organ is the longest and thickest. The limbs appear to be seven-jointed,‡ and terminate in two curved divergent claws, and a few hairs ending in little globules, a single hair far exceeding the others in length. The legs of the anterior pair are a little longer than the others. There is a wide interval between the anterior and posterior two pairs

* "Report of the Commissioner of Agriculture," Washington, 1880. Report of the Entomologist, p. 315-16.

† Investigation has not yet shown whether or not this is also so in the case of the Almond.

‡ *I.e.*, including the last claw-bearing joint which is very small.

of legs, and this interval is traversed on the back of the mite by two transverse lines the anterior of which is connected with an oblique and longitudinal line on either side. On each side of this intervening portion, and about half-way between the second and third pairs of legs, are two "eye-spots," immediately posterior to which is a small tubercle bearing a feather-like body. There are five other similarly furnished tubercles situated on the back on each side of the body. These have the following disposition: There is one opposite and posterior to the origin of each of the third and fourth pair of legs, and there are three on each side, just within the margin of the body at equal distances apart, posterior to the hind legs. Length from tip of snout to posterior border ·0010635 inch, greatest breadth (between second and third pair of legs) ·0014889 inch.

It is interesting to learn that a Bryobia mite has been previously recorded as infesting peach trees in Australia. This interesting fact having already been announced by that well-known and careful observer of the enemies of economic plants, Mr. Frazer S. Crawford.* This authority has identified his insect with the Bryobia speciosa of Koch,† but on what grounds does not appear. The original description of this species is not accessible, but the figure given by Koch which accompanies it is reproduced by Andrew Murray,‡ and with this representation Mr. Crawford's figures do not agree. The present species differs from either Koch's or Crawford's Bryobia, as far as can be learnt from an inspection of their figures of these acari.

Mr. Crawford (*L.c.*) states concerning his Bryobia mite as follows:—"The stone fruits on the plains, and especially the almond, are very subject to the attacks of a mite belonging to the genus Bryobia (Koch), and apparently the same as his *speciosa*. They are often to be found in great numbers clustered round the young shoots, especially at the forks, to which they give a pinkish grey colour, caused by the mixture of the white of the moulten skins, the red of the eggs, the pink of the young, and dirty green of the mature mites, all huddled together."

Remedies.—No remedies have been tried with a view to the destruction of the South Australian or Queensland Bryobia mites, but Mr. Crawford, having doubtless in view the known effects which sulphur has on acari, makes the following suggestion:—"A simple dusting with flour of sulphur will probably kill them. If a little common flour is added, it will improve its adhesiveness. Burford's soap and sulphur compound would likewise be an excellent remedy. The mites would in all probability be killed before their eggs, but the young ones in hatching would not survive the contact with sulphur if any be left on the tree."—*L.c.*

Habits.—Mr. Crawford remarks that in South Australia his Bryobia is found not only on the almond but on the apple and plum trees also. The Queensland mite has been found on the peach tree and also on the grape vine. In South Australia it does not seem that it accompanies any diseased condition of the trees which it infests, but in this colony, though not invariably so, the same Bryobia mite is

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* "Report on the Fusicladiums, &c." Adelaide, 1886, p. 49, pl. iv., f. 20 *a, b, c, d, e.*

† Ubersicht, p. 61.

‡ "Economic Entomology, Aptera." Lond. n.d., p. 118.

found in the case of the peach, on those leaves especially which are being injured by the presence of the Uromyces fungus, and in that of the vine on those whose tissues already support another fungus—viz., Helminthosporium viticolum, (*Sac.*).

Connection between the Bryobia mite and the Uromyces fungus.—As much has been written concerning the relation existing between parasitic acari and fungi when concomitant on the same plant, it may be interesting to consider whether or not the Bryobia mite is responsible for the presence of the Uromyces fungus. The following facts support a negative conclusion in this matter :—The mite or a close ally of it exists, on peach trees, occasionally in this colony, and as far as yet observed in South Australia, without being accompanied on the leaf by a parasitic fungus. When otherwise the Bryobia cannot be said to be invariably associated with the same fungus, as it is present with one fungus (Uromyces) on the peach, and with a different one (Helminthosporium) on the vine. Its occurrence on trees cannot in these cases determine the presence of either the Uromyces or the Helminthosporium, as fungi living on its rejected food material, since these fungi are rooted and nourished in the cell substance of the leaf beneath its surface, and therefore have quite a different habit from those which are included in the condition described as "fumagine."*

THE RED SPIDER *(Tetranychus)*.

This pest is very common in some seasons on peach trees in Brisbane, and was also observed at Toowoomba.

Symptoms.—The peach leaf presents the following appearances: The two sides of the leaf instead of extending outwards in one plane meet at an open angle, and there are irregular transverse wrinkles commencing at the midrib where also they are more pronounced. The under surface of the leaf is suffused with a white coloured tinge finely speckled with green. The upper surface is clouded with different shades of yellow. This last colour may eventually occupy the whole surface of the leaf or the latter may be mottled with light green, coppery red, and yellow. On the under surface, on either side of the midrib especially, will be noticed minute acari or mites. These are of different ages, The little spherical eggs scarcely exceeding $\frac{1}{200}$ inch in diameter with their pearl-like lustre, the colourless six-footed young, and the eight-footed scarlet-hued adults, these are all there. Amongst them, also, will be noticed numerous threads of fine silk stretched from point to point, for the Red Spider is a spinning

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* As bearing on the question concerning the relation between insects and fungi simultaneously present on plants, it may be pointed out that W. G. Smith has arrived at the conclusion, after examination of a large number of Aphides found feeding in potatoes affected with *Peronospora infestans*, that this notorious potato disease may occasionally result from the presence of these insects. In the *Gardener's Chronicle*, 1876, April 8th (p. 474, f. 88), this great authority on fungus diseases of plants, has given a magnified representation of one of the legs of a potato-aphis in which are exhibited the spawn threads of the fungus, not only traversing the limb itself, but actually emerging through its walls and developing fruit—the antheridia and oogonia. It does not follow, therefore, that in giving rise to the potato disease, a quite possible event as it appears, the aphis will do so through the agency of its rostrum or suctorial apparatus. In other words, an insect may injure a plant whilst feeding upon it without originating a fungus disease. In dealing with the Diseases of the Vine we, too, have mentioned the occurrence of spores of Helminthosporium within the body of an Acarus. (*Vid.* "Grape Vine," p. 160.)

mite, and also the skins which are cast off in process of development. The discolouration of the leaf is due to their mode of feeding—this is by eating their way into the leaf with their nipping (pincerlike) maxillary organs, and then plunging in their barbed sucker and so extracting the juice. The mites although they are most plentiful on the lower surfaces of the leaves are great wanderers also, and in their migrations find their way on to the stems and bark. The adult Red Spiders measure about $\frac{1}{16}$ inch in length.

The Red Spider is so well known and generally referred to in works relating to horticulture or economic entomology that it is scarcely necessary to give a detailed description of it.

Remedies.—In Andrew Murray's "Economic Entomology, Aptera," p. 99, the following passage relating to this subject occurs:—"The remedies that have been found by our horticulturists most effectual against such enemies as the red spider are various preparations of soap, sulphur, and quassia water; sulphur being the active principle and most efficient agent. Gishurst Compound, Veitch's Chelsea Blight Composition, are all good. Sulphur in any form seems potent. Mixed with soap, as is done in Gishurst Compound, and applied to the leaves by the syringe, it is also very useful. Even plain soap and water is said to be an effectual remedy if it reaches the insect. A quarter of a pound of soft soap whisked until it has become dissolved, is to be applied with the syringe so as thoroughly to wet the leaves; but in watering and bathing the leaves we must remember that if we content ourselves with watering the upper sides of the leaves we have done nothing, because the mites remain very quiet during the operation, and in perfect security on the lower side. It is necessary, to secure success, to use a bent syringe to send the water upwards, and to wet the under side of the leaves well with the decoction used."

Natural Enemies.—A diminutive beetle, *Rhizobius sp.*—At Brisbane the Red Spider is extensively preyed upon by a dark-coloured hairy beetle not exceeding $\frac{1}{20}$ inch in length. This insect not only feeds upon the pest in its adult beetle state, but also as a larva. The following descriptions relate to it in its different conditions:—

The Larva.—This is a small pinkish-coloured six-footed grub attaining a length of about $\frac{1}{12}$ inch. It tapers regularly towards each extremity. On the upper surface there are numerous small brown spots from which arise weak whitish hairs. These spots have the following disposition: On the three thoracic segments they are nearly uniformly distributed; on the other segments they occur in groups of three or four. There are six of these groups on each segment, two of which are lateral, and they form six longitudinal linear series continued to the hind extremity of the body. The thoracic legs are stout, and scarcely attenuated. *The Pupa.*—This measures about $\frac{1}{20}$ inch in length, and is ovate in shape. It is dark smoke-coloured. On its upper surface are a few weak simple glandular hairs in linear series; also similar, but rather larger ones on the sides. *The Beetle.*—This is broadly eliptical in shape, and densely clothed above with yellowish grey hairs of even length. The pubescence on the under surface is shorter and less dense. Head and body

both above and beneath, black. Antennæ, mouth organs and legs light yellowish brown. The head is immersed rather beyond the hind borders of the eyes. The latter are coarsely granulated. The labrum is shallowly emarginate. The sides of the prothorax are rounded, and it is rather broader behind than in front. The elytra are somewhat raised along their line of union, the epipleuræ are well defined, and extend to the hind margin. The punctures on the elytra are rather large and without regular disposition. The abdominal plates have nearly regular convex hind borders; they nearly extend to the posterior margin of the basal segment, but are widely separated from the lateral ones. They are somewhat depressed, and are impunctate. Length of beetle rather more than $\frac{1}{20}$-inch, breadth about $\frac{1}{30}$-inch.

NOTE.—This pest is found in the Southern part of Queensland on a great number of different plants, and seems to be extending its ravages. In our gardens it may be noticed on the leaves of geraniums, on those of the Blood Leaf (*Iresine Herbstii*), and also on Violets—in the last case doing much injury. It is also to be met with on quite a number of different wayside plants—its occurrence being especially noticeable on Galinsoga parviflora, Solanum nigrum, and on the Castor Oil. Plants affected by this pest always manifest some alteration in the colouration of their leaves—the normal green becomes of a lighter hue, or may be white speckled; or as in the case of the Castor Oil, the green may be replaced by various tints of yellow and red. Accompanying this change in tints there are frequently signs of arrested development in the leaves themselves. At present we are not prepared to state whether or not the acari occurring in these plants are specifically identical, although of the similarity of the effects due to their presence there can be no doubt.

THE CURL OR BLISTER (*Ascomyces deformans*).

This is an affection of, primarily, the leaves of the peach tree, which occasionally also extends to the most recently developed branchlets to which these leaves are attached. It is probably prevalent whereever the peach is grown in the colony, and is in some seasons on these trees a very noticeable feature. It is reported also as occurring in most countries in which the peach is cultivated.

Description.—The leaves instead of being green become of a pale yellow or rose colour; they thicken also a little, change somewhat their consistence, twist, curl up, get puffed, waved, and altogether present a remarkable appearance. When the branches also are involved these, instead of being smooth, become uneven and somewhat fleshy at one place, and perhaps depressed at another. If one compares the tissue of a leaf attacked by Blister with that of a sound leaf, one sees that all the cells of the leaf affected have undergone considerable multiplication. In the green parenchyma (*i.e.*, the tissue underlying the cuticle and epidermis) which is composed of cells elongated perpendicularly to the surface, one sees in the first instance what appear to be transverse partitions, and then other partitions which arise in every direction, and so the cells are multiplied and produce a homogenous fleshy tissue, composed of cells pressed one against the other, which is devoid of chlorophyl. During this time, also, the cells of the epidermis are also multiplied by the formation of septa, and so the surface of the leaf is extended, and hence the puffiness, and other characteristic features of the disease, which it presents. Between the cuticle and the epidermis globular cells will be noticed, which become angular by being pressed together. These are part of the fungus

which causes the disease, and are connected with very ramified threads (mycelium) which penetrate to the sub-jacent parts of the leaf, traversing the intervals between the cells of its tissue. The ultimate ramifications of this mycelium are in the form of little digitules which are applied to the walls of the tissue elements. If one examines a leaf badly attacked by the blister one frequently finds that its surface has a whitened and somewhat velvety appearance, which is due to the fact that the Ascomyces is in fruit, and the presence of numerous small bodies in different stages of development. In fact, the previously mentioned globular cells of the fungus becoming elongated and columnar have pushed their way through the cuticle. Towards the base of this long cell a septa is quickly formed, which separates that portion which has emerged from the surface of the leaf, from that part which is still beneath it. The former is cylindrical and terminally truncated, and develops into an ascus in which appear sporidia to the number of eight. These sporidia move towards the summit of the ascus, whence they emerge through a small transverse opening, which appears at this spot to propagate disease afresh.*

We have seen trees nearly all of whose leaves have been affected by this disease, but more frequently it is far less extensive. It exerts its worst influence when young trees are attacked by it. Mr. G. Searle, of Toowoomba, has endeavoured to trace a connection between its occurrence and the prevalence of wet weather, or other meteorological conditions, but has not been successful in doing so, neither are we in a position to state how far its presence depends on the condition of the soil.

Remedies.—This disease being one which has its seat beneath the surface of the leaf, and only manifesting itself externally when the changes characteristic of its appearances have been undergone by the tissue, it is very evident that nothing can be done to stay its development, which would be otherwise if, as Professor T. Kirk asserts, "the fungus consisted of a thin layer of cells developed on the surface of the leaf," when possibly—as in the case of the quite superficially developed mildew (Oidium) of the grape vine—"the best remedy, as he states, would be to dust the leaves with sulphur."† When peaches are grown under glass no doubt future crops would be protected if all parts affected by the "curl" were removed at an early stage of the disease from the trees, and afterwards burnt.

Leaf Rust, Shedding of Foliage (*Uromyces Amygdali*).

This disease of fungus origin is equally prevalent on the peach and on its ally the almond. When affecting the latter tree its presence is the more significant. It also perhaps occurs on the nectarine. It is equally commonly met with at Toowoomba and Brisbane. The following appearances characterise its presence :—The leaves of a tree when affected are more or less freckled with light yellow spots which as seen on the upper surface are sometimes surrounded with a

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* The above is a somewhat free translation of a note entitled "Sur la maladie du pêcher, connue sous le nome de 'Colque'" by M. Prillieux, which appeared in the *Comptes Rendus* of the French Academy of Sciences, 1872. I., pp. 1592-4. Reference might also have been made to Tulasne's paper, "Super Friesiano Taphrinarum Genere." *Ann. Sc. Nat.* 5, ser. t. v., p. 128.

† "Fruit Blights and Diseases of Fruit Trees in New Zealand." Interim report on, by T. Kirk, F.L.S, Wellington, 1885. Reprint Brisbane, 1886, p. 41.

purplish border. The colour of these gradually merges into that of the leaf, but nevertheless the spots are very distinct. In most cases these spots are small but by confluence may form patches, or the whole leaf may be yellow with a few clouds of the normal green colour. On examination of the under surface of the leaf it will be found that opposite to the above yellow spots or patches are small minute brown elevations, arising from the surface singly, in twos or threes, or there may be several together; also that immediately around the origin of these elevations the plant tissue is quite yellow. These spots of yellow tissue in course of time turn brown; the tissue which they involve becomes completely dead and often falls out. Previous to the arrival at this stage in the disease, however, the infected leaf generally drops, if not, the leaf becomes pierced with numerous holes corresponding in size to that of the spots which have preceded them. The elevations when viewed with the microscope appear to be little tufts of spore-bearing bodies and to be of fungoid nature. The particular fungus which they typify is one of the order Cæomacei, fungi parasitic on living plants, and belongs to the genus Uromyces. Specimens procured during the course of this investigation were referred to the celebrated fungus-specialist, M. C. Cooke, who pronounced them to be examples of a new fungus (*Uromyces Amygdali.**

The following is a description of this fungus :—" Spores interspersed with paraphyses formed on a stroma beneath the surface of the leaf. By rupture of the epidermis, the stroma spores and paraphyses come to the surface. Paraphyses have globular tips with walls thickened at the apex. The spores are light yellow in colour, and of very irregular form, varying from club shape to oblong, but are most often obovate; the walls are thin, except at the apex, where they are greatly thickened; the surface is echinulate, but the spines diminish in size towards the apex, and are scarcely visible upon the thick part of the wall; the endospore is pierced by two germ-pores, situated just below the thickened portion of the wall."—*F. Lawson Scribner* on *Puccinia pruni spinosæ* (Pers.), in "*Report of the Commissioner of Agriculture, U.S.A.*, for 1887." Washington, 1888, p. 354.

A peach leaf fungus has been already noticed in New South Wales by Mr. Pedley, who refers to it as belonging to the family of Ascomycetes.†

In every stage the present fungus vegetates by the growth of the mycelium within the tissue of the leaf, and the outward manifestation, previously described, only marks the occasion of reproductive organs being developed. The spores produced at the end of the summer may remain inert in the fallen leaves during the winter months, and are then available for infecting peach trees afresh. These large spores thus become the resting spores of the fungus, or teleutospores arise which do not germinate until the next season, when, what Mr. C. B. Plowright has designated a puccinoid germination takes place, a tube or tubes being

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* Since writing this, the *Report of the Vegtable Pathologist* (U. S. Department of Agriculture) for 1887 has come to hand, and from the account which he gives of what he regards as the uredinous form of the Plum-leaf fungus (*Puccinia pruni spinosæ*, Pers.), found on peach leaves, there can be no doubt, but that he has had with ourselves the same fungus under view. U. prunorum, L., *var.* amygdali, occurs in California, Caffraria, and India (*cf.* "Grevillea," *passim*). M. C. Cooke).

† Proc. Linn. Soc., N.S.W., vol. x., 1885, p. 120.

developed with secondary spores attached to it. That this is the case seems probable after what has been observed in reference to the reproduction of an allied fungus *(Uromyces appendiculatus)*.* The stylo-spores, however, produced during the uredo phase of the fungus probably take on a urenoid germination, and their germ tubes which are thrown out "are destined to penetrate the tissues of the living plant upon which the parasitic fungus grows, their main function being, not the production of secondary spores, but the direct reproduction of the parasite." But there is reason to think that these stylo-spores "do not retain their power of germination for any great length of time."

Trees which have been attacked by this pest, as we have seen, shed their leaves, the wood does not ripen, and they themselves acquire an enfeebled condition owing to this destruction of their assimilating organs. Nature makes a fresh effort to counteract the influence of the Uromyces, and the foliage is renewed again and again; but each time is reinfected by it. The energies of the tree having thus been absorbed in producing additional foliage, no fruit is forthcoming, or fruit only of a very inferior quality in small quantities. This is especially noticeable in the case of the almond at Toowoomba, where a large tree, instead of yielding from 100 to 150 lbs., bears only about 5 lbs. The effect produced by the presence of the Uromyces on the peach and almond is comparable with that occasioned by an allied fungus, *Coleosporium pingue*, Lév.—the "orange fungus" on the rose tree—the leaves of which it affects.†

There are usually one or more minute Acari, in different stages of development, to be observed crawling about the leaves, especially in the neighbourhood of the fungus.—(*Vide* "Bryobia Mite," p. 92.)

Gumming.

The external symptoms associated with the malady in the peach, plum, and allied fruit trees, which is known as "gumming" are too well known to need their being dwelt upon by us. So are the consequences on the tree of the continuance of this chronic disease.

The gum in these trees is not one of the essential constituents either of the cell-wall or of its contents—regarding a plant as an aggregation of cells. It is not an element of the sap, neither is it normally excreted by the plant, although it may occur at the site of an external injury, in which case it is formed as a product of change in the sap which issues in consequence of this injury, as is seen in the

* "Some Observations on the Germination of Uredines," by C. B. Plowright, M.R.C.S. *Grevillea*, No. 56, 1888, pp. 136-142. The opinion stated finds corroboration in what M. Lawson Scribner has published—this is, that the puccinoid form of the fungus is found in the plum.—Vide *Report of the Commissioner for Agriculture (U.S.A.) for* 1887, pp. 353-4. Washington, 1888.

† That the excessive demand on the leaf-producing energy of the almond or peach tree, to replace the foliage destroyed by the Uromyces, is the true explanation of its unfruitfulness, seems more than probable, and especially so in view of the fact that when trees are stripped of their leaves by the occurrence of a severe storm they often fail to produce fruit during the ensuing season. Dr. Anderson, in his report on the Calcutta Gardens for 1886, gives the following explanation why the mahogany trees growing in the gardens under his care failed to produce any seed during the season 1865-6:—"I ascribe this to the exhaustion f the trees by the unnatural production of leaves after the cyclone in October, 864, and again at the natural period in the end of March, 1865."

case of the young peach fruit, which in early spring emits a drop of gum to mark the situation in which it has been pierced by the ovipositor of the Yellow Peach Moth.

In a tree which manifests this disease, investigation shows that the gum is not merely superficial in its occurrence, but exists also deep in the wood of the tree. It is found, as M. Ed. Pillieux has shown, (1) in the vessels of the fibrovascular bundles, appearing within their walls in such a way as to suggest the idea of its having filtered into them from the surrounding tissue; (2) within the cells of the medullary rays, where it is evidently formed at the expense of their starch contents; and, finally, (3) the principal site of its formation is in special lacunæ or cavities. In describing these, their position, and their growth simultaneously with the formation of gum, we cannot do better than give a translation of what Pillieux has written concerning them. It is as follows:—These occur (he remarks) between the wood and the bark in the cambium-zone, but also at different depths in the wood; or they are disposed in concentric layers corresponding to the annual growths. They are formed in the middle of the cambium layer, and occupy the interval between the medullary rays. When these reservoirs of gum do not take on a very great development a new layer of woody tissue can be organised beyond them, and the growth of the wood is not notably altered. In other cases growth ceases where they occur, a flow of gum is produced, the woody tissue dies and cannot be reinstated except by little buddings from the sides where the cambium is not destroyed. The tissue bordering the lacunæ undergoes important changes. The cambium instead of woody fibres produces cells filled with starch. A special tissue is thus produced which is only found in connection with these gum lacunæ—a woody parenchyma. The starch accumulates in the tissue and it is utilised, as in the cells of the medullary rays, for the formation of the gum. These gum lacunæ increase in size at the expense of the neighbouring tissue, the elements of which are dissociated and disorganised.* This gum, then, is a degredation product derived from the starch contained within protoplasm of the cells. We are not aware under what immediate influence it is produced, at the expense of this related body. Gumming, however, especially in peach trees, has been attributed by some to the presence of a fungus (*Corynium Beijerinckii*), with which, in the first instance, the wounded parts of the trees are innoculated;† and that its origin is due to the presence of some such pathogenic organism seems probable in view of the fact that gumming may, by innoculation, be transferred from one tree, or even from one fruit, to another.

Remedy.—We have seen it recommended to transplant a tree which gums into poorer ground, or where this is impracticable to make free use of the knife or saw, but are not aware of any reason why this plan has been put forward as a remedy for the evil.

NECTARINE.

See "Peach," and Chap. I., p. 26.

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* "Etude sur la formation de la gomme dans les arbres fruitiers." Memoire de M. Ed. Pillieux, *Comptes Rendus*, vol. 78, 1874, (1) pp. 135-137.

† *Vid.* "*Gardener's Chronicle*," May 29, 1886, p. 698.

APRICOT.

Fruit Fly (*vid.* "Peach," pp. 54-75).

Unfruitfulness (*vid.* Chap. I., p. 27).

ALMOND.

Shedding of Foliage (*vid.* "Peach," pp. 97, 99).

Gumming (*vid.* "Peach," p. 99).

PLUM.

Aphis (*vid.* "Peach," pp. 83-88).

Fruit Fly (*vid.* "Peach," pp. 54-75).

CHAPTER IV.

Citraceous Fruits (Orange, Lemon, Citron, Shaddock, &c.)

Fruit Fly (*Tephritis*, sp.), *see* "Peach," pp. 54-75.

Orange Moths (Fam. *Ophiderinæ*).

There are at least two moths belonging to the Ophiderinæ which are stated to injure ripe oranges in the Moreton district. These are *Mœnas salaminia*, Cram., and *Argadesa materna*, Linn.; whilst in the Rockhampton district there is a third, viz., *Ophideres fullonica*. The second of the above insects, and probably also *M. salaminia*, occurs at Toowoomba.

The Moths.—They are all alike in that they possess the following family characters, being large, robust moths, with stout bodies extending not or slightly beyond the hind wings. Both their thorax and abdomen is crested and densely clothed. The eyes are large, the antennæ simple and not pectinated. The fore and hind wings are strongly contrasted, owing to their different colours. The former are large and stout, and have their anterior borders curved externally. The hind wings are deep yellow and usually more or less marked with black. The expanse of the fore wings measures from 2½ inches to nearly 4 inches, varying according to the sex or species. They are night-fliers.

Excluding *Ophideres fullonica* from our consideration, the remaining two insects may be distinguished as follows:—*Mœnas salaminia* (which is by far the commoner orange moth about Brisbane and along the shores of Moreton Bay) has the outer border of the fore wings straight and plain, instead of being arched and scalloped as in *Argadesa materna*. The fore wings also in the first mentioned of these two are dark green with golden reflections having a broad purplish-grey band along the anterior border, and a narrow similar band on the outer. In the Argadesa the fore wings are greenish-grey, covered with greenish-brown or purple-brown transverse confluent stripes; in the centre of the wing also are four purple-black spots, beneath which, in the female, arises an oblique white bar which is directed outwards; they have no marginal bands. In both sexes of the two insects the hind wings are orange yellow with black marginal bands and black discal spots. In the Argadesa the marginal band occupies a larger

proportion of the margin of the wing, and the central spot is also smaller than it is in the Mœnas. The expanse of wings is in *Argadesa materna* $2\frac{1}{2}$ to $3\frac{3}{4}$ inches, and in *Mœnas salaminia* 3 to $3\frac{1}{2}$ inches.

The Caterpillar. — Both insects have caterpillars of similar cylindrical form, measuring two or more inches in length when fully grown. These caterpillars have the 11th segment of the body considerably humped. Otherwise they are quite even and smooth. They are unclothed save for the presence of minute hairs. Like other Noctuæ they have each eight pair of legs, viz., three thoracic clawed, and one terminal, and four intermediate unclawed ones—the anterior pair of the last group being rudimentary. In both, the caterpillars vary in colour at different periods of their growth, but have each two large spots or ocelli on either side of the body occupying nearly the entire breadth of the 6th and 7th segments. These spots are very conspicuous, being coloured with very marked hues.

The Chrysalis.—It is contained in a light net-like web, placed within a canopy formed by the fastening together of several leaves of the plant on which the caterpillar feeds, or the cocoon only occupies the under surface of a single leaf. In this situation the chrysalis is suspended from one end. It is usually very dark brown in colour and is conical, abruptly terminated at one end and has a rough surface.

Habits.—The caterpillars feed on the leaves of different Menispermaceous plants—twiners with large orbicular or ovate-cordate leaves growing in the scrubs.* When at rest they sometimes support themselves from one or other of the extremities of the body or even hold the head and tail up at the same time; and whilst in these positions they often also bend round the head and following segments. In these respects their movements correspond to those of the caterpillars of Geometers. To the moths is attributed the habit of boring with their horny probosces through the rind of the ripe or ripening orange, whilst this is still on the tree, for the purpose of imbibing the juice of the fruit. Several, not infrequently, are said to alight on a single orange for this purpose, and to be observed with their probosces still inserted deep into the rind. It is further reported that, as a result of these injuries, the fruit drops to the ground and quickly rots. Some have denied that these moths perforate the fruit themselves, as they regard this action on their part as a physical impossibility. On the other hand, they assert that they avail themselves of the holes which have been already made by other insects† and suck the juice through them.‡

As concerning the allegations that it is a physical impossibility, it should be borne in mind that F. Moore, the monographer of the Ophiderinæ, whilst referring to the same habit in a third Australian and allied insect,—viz., Othreis fullonica, does not express any doubt regarding the accuracy of the observations which have suggested the remarks which he quotes; nor, indeed, does he question the ability of

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* It is for this reason that complaints concerning the injuries inflicted by the orange moths are more numerous in the case of orangeries which have been established in the vicinity of scrubby country. Mr. Hitchcock, of Mount Pleasant, whose orchard is thus located, informed us that during the orange season of 1886 he would have lost quite £200 owing to the attacks of the orange moth, had he not gathered up the fruit immediately it had fallen, and secured it for the purpose of converting the oranges into wine. A species of Opideres inhabits St. Helena, Moreton Bay.

† The Green Orange-tree Bug, a species of *Rhynchocoris*, forsooth.—*H.T.*

‡ *Vid.* G. L. Pilcher, *Cist. Ent.*, 1877, ii., pp. 237-240.

the moth itself to peform the mechanical operations which such depredations as have been attributed to it involve. Moreover, the curious and exceptionally formed proboscis (or applied maxillæ) has been shown by a French entomologist, M. J. Künckel, in the case of O. fullonica (and it is similar in the moths with which we are more immediately concerned) to be mechanically adapted for the performance of such an office.* The proboscis, or antilia, is made up of two applied maxillæ, and about one-eighth part of its length is occupied by the teretron or borer. This is a double organ consisting of two similar halves. One of the halves, or what is really the end of a maxillæ, is thus described by Dr. R. B. Read, of Sydney. It is spoken of as the terminal:—

"*Upper and outer surface.*—Tip acutely pointed, expanding upwards into three barbs, two of which, the first and third, are placed on the outer side, whilst the second is intermediate between them, and next the line of junction of the maxillæ. From the barbed portion the terminal begins to expand, and on its upper surface is presented, in a line above the second barb, a curved projection terminating abruptly, showing a sharp oval gauge-like edge; the interior of the projection is sharply hollowed out, and from it arises a large rounded tooth-like process. From this point commence two or more rows of thickly-set setæ, which continue the whole length of the antilia (the two applied maxillæ or proboscis). Above and on the outer side of the terminal is placed, diagonally, a second process similar to that already described, whilst above, in a line between the first and second, occurs the third. The fourth is placed above and in a line alternating between the second and third. The fifth is similarly placed in relation to the third and fourth, and the sixth and last in respect of the fourth and fifth. Each superior process is slightly larger than that below it. At the base of the sixth process, in a slightly cupped hollow, is a solitary long spine, whose office may be to prevent the teretron being plunged too deeply into fruits to permit of withdrawal.

"*Under surface.*—Tip acutely pointed, expanding upwards, then suddenly contracting, gives a sharp transverse ridge one-half way up the barbed portion, which again expands upwards and outwards, and forms a second sharp-edged transverse ridge. The remainder of the terminal is divided unequally into three divisions, each of which presents a very strong, sharp, lancet-like process. At the junction of the terminal with the remainder of the maxillæ are set diagonally upwards and outwards four conically-shaped spines; then, a space intervening, there is placed higher up the maxillæ a set of three similar spines; after a longer interval a set of two spines occurs, and finally a single spine is placed at a considerable distance from the last two, making ten in all placed like the teeth of a long harrow.

"Furnished with this extraordinary apparatus these species of Ophideres are able to pierce the skin of the orange even before it has turned yellow, two of these sometimes attacking the same fruit."†

Having seen, then, with how perfect a boring apparatus one of these moths is provided, it seems to us highly probable that it does not adopt exclusively either of the processes referred to, and that when it

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* "Les Lepidoptères, à trompe perforante, destructeurs des oranges." *Compt. Rendus*, 61, Paris, 1875, pp. 397-400 and Plate.

† "Lepidoptera having the Antilia terminated in a Teretron or Borer." Proc. Lin. Soc., New South Wales, vol. iii., 1879, pp. 150-154.

For further information on this subject we would refer the reader to an elaborate paper contained in the *Quarterly Journal of Microscopical Science* for 1875, by Frank Darwin. It is entitled "On the Structure of the Proboscis of Ophideres fullonica." Also to a note by the President of the Royal Microscopical Society (*H. J. Slack*) on a similar proboscis possessed by a Ceylon orange-piercing moth.—*Journ. Roy. Micr. Soc.*, 1878, p. 307.

finds no previous channel into the pulp, or, in the case of several moths visiting the fruit, an insufficient number, it brings this borer into requisition. This we are inclined to think after having observed, on several oranges and shaddocks which were forwarded to us as illustrations of the injury occasioned by "the borer," the character of the numerous punctures which these fruits exhibited.

Insects might, perhaps, be mentioned which are endowed with a more efficient penetrating organ than are the species of the Ophiderinæ; but then, associated with the possession of this, we require, from those who deny that these moths perforate the fruit, also the habit in these insects of employing it in such an operation. Of the insects which seek admission to the pulp of the orange, as directly affording them food—or as a nidus in which to deposit their eggs—we know of none so competent, as is a so-called orange moth, to effect a passage through the rind.

In Queensland these moths do not confine their attention to oranges. A few seasons back it was brought to our notice that at Glen Prairie, near Rockhampton, the *Ophideres fullonica* was making great havoc amongst the mango fruit, by alighting on it and extracting its juice. In other parts orange moths are reported as damaging bananas in a similar manner. In the vicinity of Brisbane we have seen them, when ripening oranges were only exceptionally to be found, amongst vines loaded with ripe fruit; and we venture to suggest that the ready way in which some grapes, notably the black Hamburg, shed their fruit may be possibly due to the fact that orange moths have visited the bunches.

Remedies.--M. J. Künckel has written that no means for the destruction of these moths, which is really practicable, presents itself to his mind. For the benefit of these who still regard them as pests, we venture to suggest the adoption of a plan made use by entomological collectors for decoying insects at night—*i.e.*, sugaring. The "sugar" is prepared in the following manner: Equal quantities of the coarsest sugar and treacle are boiled up in a sufficient quantity of stale beer, a little rum being added previous to use, and if considered advisable, some flavouring. (In this case the rind of the orange might be previously infused in the rum.) Further, the "sugar" should be poisoned by the addition, say, of some arsenical solution.* This mixture should be painted on boards hung on or near the orange trees, but not so thickly as to drop. Moths will be attracted to the "sugar" and feed on it. Of course it is necessary that these boards be carefully housed during the day, lest they become the means of destroying bees.

Leaf-eating Caterpillars (*Papilio anactus*, Macleay; *P. erectheus*, Don.; *P. capaneus*).

The caterpillars of several Australian butterflies live exclusively on the leaves of citraceous plants. Formerly feeding on the foliage of indigenous species of Citrus,† they early discovered the natural

* A solution of Arsenite of Potash may be made by boiling 64 grains of arsenic and 64 grains of bicarbonate of potash in 4 ounces of water.

† This fact, which is established through our own observation, was suggested as a matter of occurrence by that keen collector of Queensland insects, the late Sylvester Diggles, as long ago as 1866. *Vid. Queensland Guardian*, 30th March, 1866.

affinity which exists between these and the introduced economic plants of the same genus, and so now feed indifferently on either. Further, two of them (as we have observed), in consuming the foliage of the Chinese *Atalantia buxifolia* of our Brisbane gardens, emphasise the fact of the natural relationship of this plant too with the orange family.

The butterflies presenting this habit all belong to the order Papilionidæ, and as in Japan there are three species of Papilio feeding on the orange, viz., *P. memnon*, *P. helenus*, and *P. demetrius*, so in Queensland three species of Papilio, at least, share the habit. At Toowoomba we have noticed on the orange trees the caterpillars of *P. anactus* and those of *P. erectheus*, and at Brisbane these and the caterpillars of *P. capaneus* also. These pests have these characters in common: When disturbed they exsert from the front of the thorax, or part immediately behind the head, two conspicuous long tubular tentacles, from which a pungent odorous fluid is emitted. These organs, in the case of *P. anactus* are orange coloured, while those belonging to the caterpillars of *P. erectheus* are lake pink. The chryslides, again, are in each case attached to the boughs of the orange tree by the tail, and supported in this position by a loop passed over the body just behind the thorax.

The caterpillars are voracious feeders, and consume both the old as well as the young foliage of the orange. The injury due to their attacks is especially felt by young trees.

The following descriptions apply to these insects in the different phases of their metamorphoses :—

Papilio anactus, Macl.

Caterpillar.—A cylindrical caterpillar, slightly tapering towards each end, reaching a length of 1½ inches. On the back are two rows of spines extending the whole length of the body—each segment bearing two. The 3rd and 4th segment each bear an additional smaller spine below the former one. The colour of the segments is blackish-brown, with a few small yellow spots between them and at the sides; a large infero-lateral yellow spot on the 5th and on each of the segments posterior to it. The external aspect of the abdominal prolegs and a spot at the base of each thoracic leg is also yellow. The fork-like tentacle on the neck is orange-yellow.

Chrysalis.—This measures 1 inch long, and ¼-inch broad; the head is terminated by two protuberances forming a forked body. Three other protuberances form a transverse series on the back of the thorax. In addition to these each abdominal segment bears above two small elevations, which form two linear series—one on either side of the middle line. The general colour is dirty white, with large, dark-green, usually elongated blotches covering considerable areas. The chrysalis is attached by its tail end, and is held in position by a loop of black silk surrounding the body at the junction of the thorax and abdomen.

The Butterfly, Male and Female.—Head, between the eyes, orange-coloured, with a black line in the middle. The fore wings are slightly dentated, the hinder dentations being marked with white spots. There are three grey spots in the middle of the superior margin of the wing, of which the largest is the one nearest the body; on the outside of these are two parallel rows of grey spots, the first range consisting

of about nine oblong spots unequal in size, and the outer range of eight smaller whitish and round spots. The white band of the lower wings, which are not tailed, with a black crescent-like spot in the middle; and on the outside two parallel rows of five spots, the inner one blue and the outer one red. The emarginations of these wings are fringed with white. The under side of this insect is like the upper, except that the colours are more pronounced, and there are two series of two white spots on the anterior external side of the white band of the hind wings. (*W. S. Macleay* in "*King's Survey of Australia*," vol. ii., Appendix p. 458. Lond. 1827.) Expanse of wings in female about 3 inches; in male, less. The two sexes are otherwise much alike.

Papilio erectheus, Don.

Caterpillar.—Body tapering from the 5th segment backwards, above smooth, beneath with a few hairs. Two rows of spines extend along the back from the 1st to the 12th body segments. The 1st body segment has two large spines and four smaller ones posterior to these, two of which come behind the larger ones. The 2nd, 3rd, and 4th segements have their dorsal spines in transverse series of six, the central pair being smaller and anterior to the others. All the spines are dark tipped, and this colouration involves nearly the whole of the spine in the case of those occurring on the 8th, 9th, and 10th segments. The caterpillar has also a dark-brown head, and its body is green above. A broad brown lateral band extends on either side obliquely upwards from the anterior border of the 1st segment to the posterior border of the 4th, on which the band of one side unites with that of the other. There are also two other lateral oblique brown bands on each side; one arising from the anterior border of the 7th body segment extends upwards to the spine on the following segment, the other crossing obliquely the lower portion of the 9th segment. The most anterior pair have white spots at the place where they unite, the two other pairs are more or less distinctly flecked with the same colour. A broad white band also occupies the side of the body, from the 4th segment backwards, below the other bands, those of opposite sides uniting on the anal segment. This band is in places bloched with black. The thoracic legs are light brown. Length reaching 2 inches.

Chrysalis.—When about to assume the chrysalis condition the caterpillar fastens its tail to a leaf or branch by means of a black web, and having spun a small portion of the same web on such object as may happen to be on either side of the 5th body segment, connects these two points with a line passing immediately posterior to it. Thus suspended from three points, and encircled by a loop, it passes into the chrysalis state. The chrysalis of P. erectheus is much larger than is that of P. anactus, and has not the same striking colouration as has the latter. It is also much more swollen than it, the part covering the wings being in its case prominently angulated. The portion representing the prothorax instead of being simply convex is raised into a tubercle, with short ridges springing from it, directed upwards and backwards. The protuberances in front of the head also are shorter and closer together than are those of P. anactus.

Butterfly.—*Male.*—The wings are black, dentated, with the hollowed out parts whitish. The anterior wings have, on the face

towards the apex, a whitish band composed of spots, hollowed out externally. The hind wings are traversed in their middle by a broad yellowish-white band, sinuated externally, and terminated at the anal angle by a blood-red lunule, which is anteriorly powdered with blue; between this lunule and the extremity of the wing there is a second red spot more or less apparent (occasionally absent) surrounded by atoms sometimes bluish sometimes greyish. The under surface of the anterior wings differs little from the upper surface. The under surface of the hind wings is traversed in its middle by a cinereous, narrow, arched band, followed externally by two rows of lunules, of which the inner ones are blue and composed of atoms, the outer ones blood red like the anal angle. The body is black, with greyish-yellow spots in front of the corselet and towards the extremity of the abdomen. Expanse of wings, 1½ inches.

Female.—The wings black, dentated, with the hollowed out portions yellowish-white. The anterior pair have the external half cinereous, with the veins traversing it black so as to form well marked longitudinal rays. The end of the discal cell is traversed by a black band. The hind wings, like the anterior ones, are blackish-brown at the base, and velvety-black towards the extremity; their middle is traversed obliquely by a whitish band, narrowed towards each side, very large at the disc—occupying one-third or more of the discal cell, and sinuated externally; beyond this band are two rows of lunules, of which those of the anterior are formed by blue atoms, those of the posterior blood red like the anal angle; the teeth of the hind wings are more pronounced than those of the fore wings, and the fourth from the fore border is a little more pronounced than the others. The body is blackish-brown, with three whitish longitudinal lines on the under surface of the abdomen. The antennæ black. Expanse of wings, 5¼ inches*.

Eggs.—The eggs of all three butterflies are deposited singly here and there, on the foliage of the trees.

Remedies.—The caterpillars being conspicuous objects may be hand-gathered, or the butterflies themselves captured and destroyed, as they hover about the trees in quest of suitable spots for the reception of their eggs.

Natural Enemies.—Some caterpillars are altogether unpalatable to birds, and amongst such are probably those of the Papilionidæ.

An hemipterous insect belonging to the family *Halydidæ* has been observed by us to attack caterpillar after caterpillar of P. anactus, as these fed on a young plant. It would insert its rostrum into the flesh of the caterpillar, and then imbibe its body juices.

From the chrysalides of P. Erectheus, we have bred large dipterous insects belonging to the genus *Tachinus*. This parasite had attacked the insect whilst the latter was in the caterpillar state.

ORANGE TREE WOOD BORER (BEETLES—Fam. *Cerambycidæ*).

The orange trees at Toowoomba, like those growing in other parts of the colonies, are subject to the attacks of wood-borers. These are

*In these descriptions M. Godart has been more or less closely followed (*vid.* "Encyclopédie Méthodique," tôme ix., Paris 1819, pp. 31-32). This author describes the female as the type of *Papilio Ægeus*, thus following Donovan, who has figured both the male and female in his " Gen. Illust. of Entom., an Epitome of the Nat. Hist. Ins. of New Holland." Part i., p. 14 and 15.

the larvæ of beetles, which by gauging passages through and along the centres of the branches, cause the latter to either suddenly die, or snap off when under the immediate influence of a strong wind, or subject to other extraneous pressure.

Larva.—The different naked grubs which take part in this work of destruction much resemble each other, being white, elongated in form, contracted between the segments, practically footless, and swollen behind the conspicuous brown and black jaws.

There is reason to think they represent the larval forms of several distinct species of beetles.*

From the branch of an affected orange tree procured in the neighbourhood of Highfields, Toowoomba, a single specimen of a longicorn beetle was reared. This was accidently damaged, but nevertheless exhibited sufficient features by which to trace its relationship; it being apparently a member of the section *Strongyluridæ* of the true *Cerambycidæ.* The following description will serve to identify the insect:—

Beetle.—Elongated, clothed with a dense fawn-coloured pubescence, especially noticeable on elytra and metathorax. Head elongated, a slight neck, the mandibles pointing forwards, a conspicuous naked groove down the centre of the vertex passing between the antennary tubercles; the latter prominent, not quite contiguous at the base; eyes very large, coarsely granulated, deeply excavated above, the inferior lobe bordering the antennary tubercle in front. Antennæ setaceous, pubescent, unarmed. First joint narrowly fusiform (joints not serrate or flabellate). Prothorax circular in section, elongated, slightly contracted in front, having strong transverse wrinkles. Elytra elongate, narrowed posteriorly, with almost straight sides, arched, each with three carinæ extending their whole length, very obscurely shallowly punctured at base; shoulders well marked. Meta-thorax very long. Hind legs longer than the others. Anterior cotyloidal cavities open behind, intermediate ones closed outwardly. Coxæ sub-globose, anterior ones not contiguous. Femora linear or little swollen not pedunculated, with a low ridge along their lower surface; tibiæ with two small spines at ends. Tarsi with first joint longer than either second or third, but not equal to their sum; second and third joints equal, the latter deeply bifid; fourth joint longer than first, curved. Length, 1·6 inch, breadth across base of elytra $\frac{1}{4}$-inch, length of prothorax $\frac{1}{5}$-inch.

We reserve the question as to whether these beetles affect living and healthy wood, and not that which has already commenced to decay. At present we incline to the former opinion.

The Hon. W. Macleay informs us that the worst borer of the Orange tree in New South Wales is the grub of another longicorn beetle, *Monohamnus fistulator.*

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* Being of opinion that the orange trees of Toowoomba might have originally acquired this pest from the indigenous citraceous shrub *Atalantia glauca*, growing in the plains at no great distance from the district, we requested Mr. H. Hurst, of the Queensland Museum, who happened to be stationed at Chinchilla, to examine carefully shrubs of this plant and secure examples of any insects that they might yield. Amongst those thus procured were a number of grubs (borers) scarcely to be distinguished one from another, and three kinds of beetles. These all belonged to the family Cerambycidæ, and represented three distinct species, viz., *Pachydisus sericeus, Xystrocera virescens,* and a third and interesting insect allied to *Phacodes.*

Remedy.—We are not able as yet to give means for protecting orange trees from the attacks of pests of the description of the above; but the suggestions made in dealing with the borer of the peach (Orthorhinus) (see p. 79) may be, perhaps, advantageously carried out in the case of orange-borers also.

Bark-eating Beetle (*Orthorhinus, sp.*).

Mr. W. Hill, of Eight-Mile Plains, near Brisbane, has submitted specimens of a beetle closely allied to the Peach Wood Borer, accompanying which was a branchlet from an orange tree, the green bark of which had been gnawn off in patches by these pests. Such injuries, if prevalent to any extent, would become a formidable obstacle to the growth of the tree. (*Vid.* "Peach Wood Borer," p. 79.)

Bladder Cicada (*Cystosoma Saundersii,* Westw.).

This insect was reported as being injurious to the orange in New South Wales, by Dr. G. Bennett, of Sydney, in 1870;* and during the inspection of the gardens at Toowoomba, Mr. C. J. Hartmann drew attention to Cystosoma as an orange-tree pest. Whilst on a visit also to Mr. Roessler's Orangery at Crown street, it was observed that the empty pupa cases of the same insect were still adherent to the trunks of orange trees.

The Cystosoma is a cicada (*i.e.*, a "locust" according to the misapplication of this word made by the colonial youth), and has habits somewhat resembling those of the insects included under this general term. For example, during its larval condition it feeds on the roots of plants, and accordingly is highly destructive to them. It is probable too, that, as with the cicada, a considerable time is occupied in this early phase of existence. The fact of an American species of cicada passing seventeen years in its larval state seems to have been well authenticated.

There is, however, little precise information concerning Cystosoma, except such as relates to its appearance when adult. In the case of other cicadas, the eggs are deposited in artificially constructed grooves or serratures in the bark of trees, and the larvæ in emerging from these eggs soon make for the ground, and so find their way to the roots on which they are henceforth to subsist.

The adult male Cystosoma saundersi is of a uniform yellowish-green colour and measures from $1\frac{3}{4}$ to 2 inch. in length, and $3\frac{3}{4}$ inch. from to tip of expanded forewings. It has the abdomen very much inflated; the bladder-like body, thus formed, exceeding $1\frac{1}{4}$ inch. in length, and being $\frac{3}{4}$ inch. in breadth and height.† The large lateral transversely striated "musical tympanæ" are very conspicuous on each side of the body. The outer half of the forewings, unlike the same portion of these organs in other cicadas, is very much netted and so exhibits numerous sub-hexagonal cells. (*Cf.*, J. O. Westwood, in "Arcana Entomologica," Lond., 1845, vol. i., pg. 92, pl. 24, f. 1, 1a-1d.)

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* "Industrial Progress of N. S. Wales." Sydney, 1870, p. 685.

† Note.—The possession of this extraordinarily inflated hind-body is not alone characteristic of the genus Cystosoma (bladder-body), for a bright green-coloured cicada occurs in the neighbourhood of Brisbane, measuring $1\frac{1}{4}$ inch. in length, which presents this feature, but does not exhibit the highly reticulated wings.

ORANGE APHIS (*Siphonophora citrifolii*).

The new shoots, tender buds, and young foliage are the parts which are subject to the attacks of this pest, and these, owing to the presence of the aphides, may assume quite a black appearance. Their effect on full-grown trees is not immediate, but being present they are checking the growth of what is to become the fruit-bearing wood of future years. When young trees are, however, badly infested with this insect their growth may be very greatly retarded.

Viviparous wingless, and winged aphides, as well as the earlier stages of both classes, may be found together on the tree during the early months of the spring.

The orange Aphis of America is *Siphonophora citrifolii*, Ashmead.* The original description of this insect is not accessible to us, but J. H. Comstock states that it is about five hundredths of an inch in length, green in colour, shaded with dark brown upon the back and sides. † No other orange aphis seems to have been described. Professor Kirk writes concerning the species which infests citrus trees in New Zealand that "the colour of the insect is brownish-black," and that he is unable to identify it. Whether or not the Queensland insect is the same with either of these may be determined by those who are in a position to compare the following descriptions with the characters presented respectively by the Siphonophora citrifolii of America, and the "brownish-black" insect referred to by Professor Kirk.

Viviparous wingless female.—This is of a general dull dark-brown colour, the surface being microscopically netted. The body is ovate and little convex; the thoracic divisions are well marked; there is a broad conspicuous ridge bounding the body on each side and extending from the first thoracic segment to beyond the origin of the nectaries. These last are well developed, each measuring ·015 inch in length. The terminal abdominal segment is narrow, roundly fusiform, increasing somewhat in length distally. The head is convex between the eyes, the antennæ (feelers) seem to arise from frontal tuberosities and sometimes reach to the origin of the nectaries, though they are generally of less length. The second joint is distinctly longer than the first; the third and fourth joints are subequal and are each about equal in length to the succeeding three. These are difficult to separate, but the fifth is twice as long as the seventh, and the sixth very much shorter than either. The limbs are clothed with numerous erect hairs, and there are a few white erect hairs on the penultimate and terminal abdominal segments. A few bristles are on each antenna. The femora, the proximal ends and distal portions of the tibiæ, the feet, as also the first and second joints, distal portion of 4th joint and succeeding joints of the antennæ, are dark-brown. The remaining parts of these organs are very slightly tinged with pale brown. Total length of body and head ·09 inch, greatest breadth ·05 inch.

Viviparous Winged Female.—This has generally the same colour as the wingless female. The antennæ are usually shorter and scarcely exceed half the length of the body. The fourth joint is about equal to the fifth, and each of these is less than the third, but plainly exceeds

* "Orange Insects" Jacksonville, 1880, p 65.
† "Report of the Entomologist." Washington, 1880, p. 248.

the two following. Of these the seventh is plainly shorter than the sixth. The wings measure . . . inch in length. The ribs are very light brown, the brand (stigma) is yellow-brown, and the veins darker brown. The second vein diverges from the first, and is parallel to the third together with its first branch. The first and second divisions of the third vein are about equal, and each is about double the third. The stigma measures ·028 inch. The *Pupa* has light green-coloured wing-covers.

Rate of Increase.—Five larvæ were found within the body cavity of a single wingless female. The number of generations produced during a year has not been observed.

NOTE.—For rate of increase, ant relationship, remedies, and other remarks on aphides, consult the article on the Aphis of the Peach (pp. 83-88).

SCALE INSECTS.—THE COTTONY CUSHION SCALE (*Icerya Purchasi*, Mask.).

This pest was not noticed in the Toowoomba district; but it occurs on and is destructive to several kinds of cultivated plants in the neighbourhood of Brisbane. Elsewhere in Australia it has been reported as existing in the vicinity both of Melbourne and Adelaide, and beyond this continent it is found at the Cape of Good Hope, in California, and in New Zealand. We have met with it, too, as a not uncommon insect, in the vicinity of Sydney. Icerya is an insect which is spreading, and into whatever country it extends it carries destruction, to the plants which it affects, with it. At present it is perhaps exercising the attention of entomologists more than is any other pest to vegetation. Its appearance, habits, nature, the extent of its ravages, and the history which has marked its occurrence and progress in different countries cannot, then, be too generally known. Also, it is equally expedient to dwell on its natural enemies, and the means which have been adopted or are available for checking its ravages or annihilating its existence. It may be objected that it has long been known in this colony, and that it is not equally destructive here as in other countries. Should this be admitted, the fact remains that it is not generally distributed in Queensland; and there can be no doubt that when once it finds its way to a district in which its occurrence is a novelty it will spread and be as prejudicial to the health of cultivated plants there as it has been found to be, on introduction, in other countries.

The following is a popular description of the female Icerya—the sex usually met with:—When full-grown the insect with its egg bag is "half-an-inch long . . . The convex dorsal surface is reddish and powdery, but to its posterior margin grow (compacted together) waxy hairs to a considerable distance (forming an ovisac). The upper surface of the mass is furrowed as if marked by the teeth of a comb. Under the microscope the wax is seen to consist of spiral fibres, which when broken appear as rings." *

* "Coccus Insects," by Dr. J. Bancroft. A popular paper read 30th July, 1869. *Trans. Philosophical Society of Queensland*, Brisbane, 1872. On first reading this description it occurred that the author had in view the Icerya Purchasi, and this conjecture has since been verified by consulting him. On visiting Cape Colony, in 187–, Dr. J. Bancroft then met with this insect in a fresh habitat, and from his previous experience was able to support the conjecture, already prevalent there then, that the pest had been introduced into that country from Australia.

The following scientific description of the insect as it appears at different stages in its growth is given by the authority who first gave a detailed account of it*—W. M. Maskell, F.R.M.S., Registrar of the University of New Zealand :—

Adult Female.—Dark reddish brown, covered with a thin powdery secretion of yellowish meal, and with slender glassy filaments ; stationary at gestation, and gradually raising itself on its head, lifting the posterior extremity until nearly perpendicular, filling the space beneath with thick white cotton, which gradually extends for some distance behind it in an elongated white ovisac, longitudinally corrugated ; ovisac often much longer than the insect, and becoming filled with oval red eggs. Length of female, about $\frac{1}{5}$ inch, reaching sometimes nearly $\frac{1}{3}$-inch. Body previous to gestation lying flat on the plant, the edge slightly turned up; on the dorsum a longitudinal raised ridge, forming one or more prominences. Insect covered all over with numerous minute fine hairs, most thickly on the thoracic region; round the edge these hairs are longer, and are arranged in tufts somewhat closely set; the tufts are black and contain from twenty to thirty hairs in each. Amongst the hairs in the tufts are several protruding tubular spinnerets, having on the outer end a kind of multi-locular ring or crown; from these proceed cylindrical, glassy, straight tubes as long as the tufts of hair. Long, fine, glassy delicate filaments, as long as the body of the insect, radiate from the edge all round; but these being very fragile are often irregular, or absent. During gestation thick, short, cottony processes form at the edge of the thorax, seemingly attached to the feet. Antennæ of eleven joints, very slightly tapering ; each joint bearing hairs. Feet normal, somewhat thick. Rostrum not long ; mentum triarticulate. Procreation commencing soon after the first formation of the ovisac, the eggs being ejected into the sac as it grows ; ovisac at completion containing sometimes as many as 350 eggs; ovisac convex above, sometimes irregularly split, more often nearly conical, divided by several regular longitudinal grooves or ribs.

Female of Second Stage.—Dark-red, elongated, slightly convex, active, covered with thin meal, or short curly cotton. Body hairy, with marginal tufts and spinnerets as in adult. Anal tubercles inconspicuous, but the abdomen exhibits three small lobes on each side, from which spring six short setæ. Antennæ of nine nearly equal joints, hairy. Feet normal, thick. Several radiating, fine cottony filaments. Length of insect variable from $\frac{1}{10}$ to $\frac{1}{6}$ inch. The dorsum exhibits the longitudinal raised ridge, but less conspicuously than in the adult.

Young Larva.—About $\frac{1}{24}$ inch long, dark-red, elongated, flattish, active, covered with yellow cottony down. Antennæ of six joints, hairy ; the last joint is much the largest, clavate, apparently four-ringed, bearing four long hairs. Feet slender; digitules short fine hairs. Eyes prominent, tubercular. Mentum biarticulate. Anal tubercles represented by three small processes at each side of the abdominal extremity, each process bearing a very long seta. Six longitudinal rows of circular multilocular spinnerets, four in the dorsum and one on each edge. Alternating with these are rows of hairs with tubercular bases.

Adult Male.—Large, the length slightly varying ; some specimens reach, $\frac{1}{8}$ inch ; expanse of wings $\frac{1}{4}$ inch ; length of antennæ about $\frac{1}{8}$ inch. Body red, with a shining, diamond-shaped black patch on the dorsal surface of the thorax ; legs and antennæ black. Wings dark-brown with (in some lights) a bluish tinge, marked with oblique narrow, wavy stripes ; main nervure red, branching once ; there are also two longitudinal whitish narrow bands. Antennæ very long and slender, with ten joints, which may easily be taken for nineteen, for after the first, which is short round and simple, all the other nine have two dilated portions with a constriction in the middle, and on each dilation is a ring of very long hairs, giving the antennæ a feathery

* "Transactions and Proceedings of the New Zealand Institute." 1878, vol. xi., p. 221.

appearance. Eyes very large and prominent, almost pedunculated, brown, divided into numerous semi-globular facets. Feet long and very hairy, coxæ short and thick, tibiæ long and slender, claw thin; upper digitules absent, lower pair only short bristles. Abdomen slender, segments somewhat distinct; on each segment some hairs; the last segment ends in two thick, conspicuous cylindrical processes, which in side view are seen to be inclined upwards, and beneath them is the short, conical spike sheathing the penis. Penis red, longish, tubular, and thick, with many recurved short hairs, and at the end a ring of short spines. Each of the two processes on the last segment bears three or four long setæ, but there do not appear to be any of the long cottony appendages seen in the males of most Coccids.—*W. M. Maskell.**

Egg.—Red in colour, true oval in shape, 0·7 mm.—*Comstock.*†

Habitat.—In the neighbourhood of Brisbane we have seen it on the following cultivated plants:—The rose, the honeysuckle, a species of Cassia, on Spiræa, on Acalypha (small red-leaved species), on the orange, on Ficus pumila, Acacia Farnesiana, and on the four following native shrubs:—Bauhinia Hookeri, Tristania conferta, Eucalyptus microcorys (young plants), and Acacia Farnesiana‡ (growing in gardens); and at Sydney on Pittosporum undulatum and Acacia juniperina.

At the Cape it has been reported as occurring on the orange, the Australian blackwood (Acacia melanoxylon), on other species of Acacia, on the Pittosporum tobira, on roses, on Coccoloba, and, according to E. J. Dunn,§ also on medlars, pears, oaks, quinces, cape plumbago, pomegranate, strawberries, and French beans. In California, citraceous trees, the Eucalyptus, the rose, the privet, and the Spiræa are stated to be affected by it. In New Zealand, according to Maskell, the coniferous trees (cypress, pines, firs), citraceous trees, roses and sweet briars, gorze (Ulex. sp.), wattles (Acacia spp.), kangaroo acacia, and various greenhouse plants; and, according to Professor Kirk, on the native Leptospermum scoparium. At Melbourne, on the Pittosporum (eugenoides), and in the neighbourhood of Adelaide, on garden roses.

History of its occurrence.—The first reference to its occurrence seems to be that made by Dr. J. Bancroft, who, as we have seen, had met with it in 1869, in the neighbourhood of Brisbane—"on orange and other trees."‖ At an earlier date, 1848, Sir R. Schomburgh, in his History of Barbadoes, wrote:—"The orange and lime trees were subjected to great ravages from the insect tribe. The female of a gall insect covers itself with a white cotton-like stuff, in which it deposits its eggs to the number of from 150 to 400. The young brood feed on the tender parts of the tree, and multiply so rapidly that they have been known to destroy whole groves of orange trees. It is a species of *Dorthesia*, resembling D. citris."

* "The Scale Insects (Coccidæ)." Wellington, 1887, pp. 104-106, cf.

† Report of the Entomologist. Department of Agriculture, Washington, 1880, p. 347.

‡ If indigenous to Australia certainly not to Southern Queensland.—H. T.

§ *Melbourne Argus*, Aug., 1886. The information is conveyed in a letter dated 29th July, and as this communication contains more than one error in statements regarding well-ascertained facts, and as the writer refers to two distinct insects at the same time under one designation, the accuracy of his list also may be called in question.

‖ *Trans. Philosophical Society of Queensland.* Brisbane, 1872.

It was noticed in 1872 at the Cape, as we learn from a letter dated 6th January, 1874, addressed by James McGibbon to Dr. Hooker, of Kew. This letter was read at a meeting of the Scientific Committee of the Royal Horticultural Association, on 18th March, 1874. It is as follows:—" I have taken leave to enclose in the box along with the seeds a small box of insects, which I will ask you to be good enough to give me some information anent. This pest has only made an appearance within the last two years, and appeared first on a specimen of Acacia melanoxylon. It spreads with wonderful rapidity. Species of Acacia of Australian types are its preference; indeed the insect is not found on any native plant. Coccoloba platyclada and Pittosporum Tobira are covered with it."*

In 1876 it was first observed in New Zealand, Dr. Purchas having found it in March of that year, on kangaroo acacia, in Auckland. At this time, according to Dr. Purchas and Mr. Cheesman, it had only been found on one hedge composed of this plant, and nowhere else.†

In 1877 we have the first record of its existence in California, but at this date it had already spread all along the coast countries of that state.‡

Meanwhile at the Cape, as the Curator of the South African Museum reported to the United States Entomologist, C. V. Riley, "it had multiplied at a terrible rate and had become such a scourge as to attract the attention of the Government" of that colony.§

In New Zealand by June 1878, this Icerya, which two years previously had been reported as only existing on a single hedge in Auckland, had just reached Napier, in Hawkes Bay province—a fact pointed out by W. M. Maskell, which we are able to corroborate from our own observations during that year.

In California its ravages, too, in 1878, were giving rise to serious complaints, that it was killing " many of the orchard and ornamental trees," and the justness of these was ascertained by the United States Chief Entomologist, J. H. Comstock, who with an assistant was deputed, in July 1880, to visit the celebrated orange-growing district of Los Angeles to study this and other Coccid insects, which they did during a residence there of two months.

To-day we learn concerning this pest from the Cape, in the words of the Hon. P. L. Van Der Byl: " Since the introduction of the . . . bug into our colony, it has simply swept thousands of acres of land of the oranges. We have no oranges now within 150 miles of Cape

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* *Gardener's Chronicle*, 1874, p. 384. This letter was read by Professor Thiselton Dyer, and Professor Westwood, who examined the specimens accompanying it, stated that " The insect . . . was quite new to him, and was closely allied to Cionops cataphractus, a rather rare British insect allied to the Coccidæ." Cionops is a synonym of Dorthesia, having been applied to the male of that coccid. The Cape insect has been recently identified with Icerya Purchasi by a well-known specialist on Coccidæ—Dr. Signoret.—H. T.

† *Vid.* " On some Coccidæ in New Zealand." *Trans. N. Zealand Institute*, vol. xi., 1878, p. 220.

‡ *Californian Agriculturist*, December 1877. This reference is given by J. H. Comstock. *Report of the Etomologist.* Annual Report Depart. Agric., 1880. Washington, 1881, p. 348.

§ *Report of the Entomologist.* Annual Report Depart. Agric., 1878. Washington, 1879, p. 208.

Town. . . . It is so destructive that we do not think of planting an orange in the colony. The only place in the colony where we have any oranges is where we have the dry frosts at night."*

In a similar strain, and also referring to its devastation at the Cape, E. J. Dunn, too, states as follows:—"It has completely annihilated the orange trees as far as it has gone—for 100 miles up country . . . . Orange cultivation entirely ceased in consequence of this insect . . . . There are simply dead stumps left of some of the trees . . . . Many men have lost incomes of several hundreds a year through it."† On another occasion the same witness states, "It is still advancing steadily and leaving destruction in its wake, and will continue to do so as long as suitable food is within its reach."‡ In New Zealand, from its original centre in Auckland, it has spread both north and south. In December, 1881, we found it at Whangarei, and in 1885 it was at the Bay of Islands,§ where it was not observed by us at the earlier date. In 1883 it had established itself in the Napier District, and during the same year complaints were made of its ravages in Nelson, beyond Cook's Straits, though whilst resident in the district during the early months of 1880 and of 1881 it was not brought to our notice as occurring there.

Referring to these several localities as witnesses of its destructive habits, W. M. Maskell writes as follows:—"In Auckland it has destroyed whole orchards of the same (*i.e.*, citraceous) trees, and in Nelson and Hawkes Bay it is a dreadful pest on all kinds of plants."|| From California, since this last sentence was written, came the information: "The insect Icerya Purchasi has there, especially in the southern part of the State, gained such hold on the orange groves, in spite of the most strenuous efforts, that the people find it impossible to keep it down."¶ Our first reference was to its Australian habitat, and we shall now proceed to the notices of its occurrences in Victoria and South Australia. In July, 1886, a coccid was observed by Mr. Guilfoyle, Director of the Botanical Gardens, Melbourne, at the entrance to the Custom House in that city. This was on a Pittosporum. Mr. E. J. Dunn, who had long been engaged in agricultural pursuits at the Cape, identified this insect as the coccid which was so destructive in that colony, and at once drew attention to the fact.** Examples on twigs of this plant, forwarded by Mr. Guilfoyle, almost immediately came under our examination, and from our previous acquaintance with the insect we were able to confirm the opinion as to their nature, already arrived at by E. J. Dunn, and reiterated by him.††

* Royal Commission on Vegetable Products, Victoria. 1st Progress Report, and Minutes of Evidence, p. 27. 8th December, 1885.

† Royal Commission on Vegetable Products, Victoria. 3rd Progress Report and Continuation of Minutes of Evidence, p. 98. 18th August, 1886.

‡ *Argus*, Melbourne. August, 1886, in a letter dated July 29th.

§ "Fruit Blights and Diseases of Fruit Trees. Interim Report," by Professor T. Kirk. Wellington (1885).

|| The Scale-Insects (Coccidæ). Wellington, 1887, p. 107.

¶ State Inspector of Fruit Pests for California, in a letter to W. M. Maskell. *Op. cit. addendum.*

** *Vid.* Letter, dated July 29th, in Melbourne *Argus*. Aug., 1886.

†† Royal Commission on Vegetable Products, Victoria. 3rd Progress Report and continuation of Minutes of Evidence, *l.c.*

The Icerya, however, was not confined to the spot where it was originally noticed, for in September, 1886, it might have been seen "in several other places."*

At least as early as in December, 1885, a great deal of the Icerya was to be seen in South Australia, as we learn from the testimony of the Hon. P. L. Van Der Byl—not, however, on the oranges there, but on the hedges †; and during this year (*i.e.*, 1887) Frazer S. Crawford, inspector under the "Vine, Fruit, and Vegetable Protection Act," South Australia, has forwarded us from Adelaide lithograms and photographs illustrating the occurrence of Icerya on the rose, and several of the structural characters of the insect.

In Queensland we have met with it, or in a few cases have received it, from the Southern portion of the colony only, viz.: along the valley of the Brisbane from the Hamilton to Oxley, in the gardens of the Queensland Acclimatization Society, in Victoria Park, Albert Park, and Wickham Terrace Reserve ; in the vicinity of Samford, and at Cleveland. The plants on which it occurs in these localities are mentioned under Habitat (p. 53). Mr. Koebele informed us that he saw it at Toowoomba, but a single specimen only.

Remedies.—In view of the history of the ravages of Icerya Purchasi we would prefer not to suggest any remedies to be tried in order to save a tree infested by this pest, but rather that the tree itself should be destroyed ; nevertheless, though we recommend this extreme measure we do not regard it as imperative, since the limit of possibility to a scientific investigator in these matters is seldom attained by him or even thought of by the cultivator of the soil, and, moreover, little discouragement is experienced by us in reciting these testimonies :—

"The vast powers of increase (of the Icerya) and its peculiar structure render all attempts to check its progress unavailing."—*E. J. Dunn.*

"In spite of the most strenuous efforts the people find it impossible to keep it down."—*State Inspector of Fruit Pests for California.*

A recent issue of the *Los Angeles Herald* recommends a plan in the case of oranges : This consists in placing straw sprinkled with kerosene beneath each tree, and igniting the straw. The sudden kerosene flame is said to extirpate the insect in five minutes. After which the burnt branches could be cut, reliance being placed on the recuperative property of the tree in establishing it in its previous vigour. Where gas is available the same paper relates concerning the charging a balloon tent placed over the tree, that this method "has effectually killed the pest whenever tried."

W. M. Maskell writes : "The best authorities in America have come to the conclusion that the only cure is the destruction of infected

* Commissioners to witness. *Op. cit.*, p. 120.

† It has since transpired that this witness was in error, he having mistaken another insect for the Icerya. Mr. Crawford received it from locally-grown rose trees, and transferred it (for purposes of study) to Pittosporum. From the latter plant it spread spontaneously to the orange, and thereby caused some alarm. Mr. Crawford's final conclusion is that it does not belong to this part (*i.e.*, Adelaide) of South Australia. Cf., Royal Commission on Vegetable Products, Victoria, Fourth Progress Report, pp. 130-131, March, 1887.

plants,"* and "the best plan would be to burn at once any tree found infected with it;" † and again, "*A speedy burning of every infected tree is the best remedy.*" ‡

Cause of and Checks to its Increase.—The cause of its increase lies in its unchecked natural reproductive powers. The following circumstances retard this natural increase, viz., unfavourable climatic conditions, unsuitable food, the presence and unhindered development of its natural enemies. When these conditions are absent, or obtain only in a slight degree, the Icerya, like other insects, will increase to the full extent of its inherent capabilities; and we have the history of its ravages at the Cape, in New Zealand, and in America, ever repeating itself. We will instance the truth of this statement from what we know of the Icerya Purchasi itself. In Queensland it may have existed since 1869, or from an earlier date, and its insect enemies, which now so largely destroy both it and its progeny, may have checked it in its ravages for nearly twenty years and may continue to do so. So may the hemipter, which, in 1885, according to Mr. Molyneux, attacked this insect whenever, in Adelaide, it appeared on the orange by "putting its proboscis into the bug, sucking it perfectly dry and so killing it," § continue there to protect Citrus trees; or the special dipterous parasites, discovered by Mr. Crawford, perform a like service. Even further, when the unfavourable circumstances have full force, as quite recently at Orange, Los Angeles, California, there may be what to the uninitiated is "a wonderful and mysterious disappearance of the destroying fiend without any attempt being made at its destruction." || On the other hand, the partial or full play of these checks to increase may, in the case of the Icerya, as in that of other insects, even though their operation has been felt for a number of years, be suddenly or otherwise suspended, and we have then the re-occurrence of devasting swarms of it. Hence the existence of shrubs in the colony, and especially in our public gardens, already supporting and dying from the effects of this "Cottony Cushion Scale" is not altogether insignificant. When its ravages in New Zealand were yet only commencing, W. M. Maskell wrote as follows:—"Nobody seems to try to destroy it. With the example of California and the Cape of Good Hope before us, we may be sure that ere long this pest will become a dreadful nuisance. I have tried to warn the people of Nelson and Auckland, but no remedy has been attempted." ¶ Events have shown the accuracy of this surmise, and the results of the inertia of the New Zealand colonists.**

The same indifference as to their interests was in existence amongst the orchardists of California. "When (the *Los Angeles Herald* informs us) it first appeared in the city of Los Angelos, and its character and ravages became known, it might have been ex-

* *Trans. New Zealand Inst.*, 1883, vol. xvi., p. 141.

† "The Scale Insects," p. 107.

‡ *Op. Cit.*

§ *Vide.* Hon. P. L. Van Der Byl. Royal Commission on Vegetable Products, Victoria. First Progress Report, &c., p. 27. 8th December, 1885.

|| *Los Angeles Herald*, 1877.

¶ Trans. N. Z. Inst., 1883, p. 140–141, 4th October.

** In the neighbourhood of Brisbane it still (September, 1889) fortunately happens that its parasites are keeping it from increasing to any great extent.

terminated for less than 500 dols. But the people refused to burn the trees." Again, at the Cape, E. J. Dunn informs us : "It was too late before they took the matter up—the insect had got a start."

Natural Enemies.—The part, if any, that birds or other vertebrate animals play in destroying the Icerya Purchasi has not been recorded; neither is there mention of an insect in any way parasitic upon it, as it occurs in California, in New Zealand, or at the Cape. For Australia, however, we have to record the following:—

1. A small *dipterous* insect. Mr. Frazer S. Crawford, of Adelaide, a short time since sent to the United States Entomological Department a small two-winged insect which he had found parasitic on Icerya, in South Australia. This has been described by S. W. Williston* as the type of *Lestophonus*, a new genus of *Oscininæ*, and named *Lestophonus Iceryæ*. The Lestophonus has been introduced in quantity to America for liberation in infected orangeries there, by the U. S. Entomologist, through the agency of Mr. A. Koebele, who was sent on a special mission to Australia for the purpose. Mr. F. A. A. Skuse† has quite recently described a second species, *L. Monophlebi*, bred from the coccus *Monophlebus Crawfordi* (Mask.), in the first instance by Mr. F. S. Crawford. Hitherto these dipterous parasites have not been observed in Queensland.

2. A small *hymenopterous* insect. This is very common about Brisbane, and, like the Lestophonus in Adelaide, has no doubt checked the Icerya in its ravages here. It usually happens that quite a number infest a single individual of the Cushion Scale.

This parasite is a small brown insect, measuring nearly 1½mm. in length, and with wing expansion of two millimetres. It has a smoky patch crossing the extremity of each fore-wing. In physiognomy it must resemble the parasite (*Semiotellus destructor*, Say) of the Hessian fly.‡

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* U. S. Depart. Agric, Division of Entomology, "Periodical Bulletin," July, 1888, vol. I., No. 4, p. 21, fig. 3.

† Proc. Lin. Soc. N.S.W., Feb., 1889, vol. IV. (series 2), pp. 125-6.

‡ Absence of sufficient literature prevents us from assigning this insect its correct position amongst the Chalcididæ, but the following description may assist others in doing so:—

Male.—Head large, very much compressed opposite the eyes from before backwards, so as to present a transverse aspect when viewed from above. Eyes, separated by a very broad front, very large, forming prominent lateral angles; ocelli (in each sex), three in number, forming a very obtuse triangle; antennæ arising close together, very far forward on the face, seven-jointed (*i.e.*, counting the scape as the first joint), each joint except scape and terminal one contracted anteriorly, and laterally compressed, so as to appear moniliform when viewed from above and dentate when seen from the side; scape rather exceeding two following joints, cylindrical; second joint shorter, and third joint longer than any of the other joints, except scape and terminal one; 4th, 5th, and 6th subequal. Terminal joint of antenna oblong and obtuse. Metathorax shortly produced behind, and abdomen, which is obovate, contracted in front, and shortly pedunculate; first joint of abdomen greatly developed. Succeeding segments more or less drawn in, causing abdomen to appear as if truncate. Wings, with the costal vein long continued, extending about as far beyond its expansion as is the distance from the latter to the base, the portion beyond the clubbed branch being about as long as the clubbed branch itself. Just internal to the expansion is, apparently, a branch extending downwards and inwards, and so forming a basal cell; the course of this vein being indicated by a dark greyish discolouration, and a patch of black pubescence. A very fine vein extends for some distance along and a short way anterior to the hind border. The outer half of the wing is clothed with short hairs, and bristles occur along the

3. A small brown beetle, measuring about $\frac{1}{10}$ inch in length. Of this a single specimen only is available for description, and it becomes therefore impracticable to define its minute characters. It appears to be a somewhat aberrant form of *Rhizobius*. The following are the more salient features which it exhibits :—

It is broadly ovate; the elytra and prothorax are reddish-brown, the abdomen beneath being rather darker brown. The head, thorax-beneath, and the legs are piceus. The mouth organs and tarsi are brownish-red. The whole upper surface is densely clotted with erect rather short light-brown pubescence of even length. On the under surface it is less dense and adpressed. It is also closely and rather finely punctured—the elytra densely so. The head is immersed to a little beyond the hind borders of the eyes. The prothorax is strongly and widely excavated in front, with the sides anteriorily depressed, and with the anterior lateral angles well marked. The elytra are wider than the prothorax and are transversely elevated opposite the humeral angles. The epipleuræ of the elytra are continued to the hind borders of the latter, rather broad—especially beneath the shoulders, and are sparingly clothed with bairs. The tibiæ are very much compressed. Length, 2·5 mm. (1¼ lines), breadth, 2 mm.

4. In Adelaide, as previously noticed, the "Cottony Cushion Scale" when it frequents the orange is also attacked by an hemipterous insect which, with the dipterous one, seems there, now, to check its ravages.

Its Designation.—At the Cape the insect has been known as (1) the Australian Bug—in deference to the opinion that the colonists there received the insect in the first instance from Australia, (2) as the *Dorthesia*, since Westwood, to whom the insect was referred in 1874, pronounced to be closely allied to a species of that genus.* In California, too, it is known by the name of Dorthesia—Dr. H. Behr, of San Francisco, having pronounced in 1877 that it was a Dorthesia, and Professor Riley having the next year stated that it was apparently identical with the Dorthesia characias, *Westwood*. It is also spoken of in America as the "Cottony Cushion Scale." In New Zealand its identity with any species of Dorthesia has not been suspected, and therefore this name is not current in that colony. Professor Kirk very inappropriately designates it "White Scale." In Victoria, owing to its having been first recognised there by visitors from the Cape, it has received the name of Dorthesia. For Queensland we would suggest that, whilst it is permitted to exist in the colony, it should receive its correct titles—Icerya Purchasi or Cottony Cushion Scale.

Its native country.—When writing in January, 1874, concerning this pest, which then had recently appeared at the Cape, Mr. J. McGibbon was silent on the subject of its native country. Dr. A. W. Saxe, of Santa Clara, California, in December, 1887, "stated it was his belief that the pest was originally brought from Australia as early as 1868." W. M. Maskell, in his paper "On some Coccidæ in New

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costal vein. The legs—especially the hind pair—are long and very swollen; the swollen femora and the tibiæ are both long and about equal; the first joint of tarsi about equal to the two succeeding. Length, 1½mm.

The *female* has the antennæ eight-jointed, and neither moniliform nor dentate; the second joint is shortly fusiform; the third to seventh present the following characters:—They are broader towards the end and truncated, the third joint is the smallest, the fourth equals the third and fifth together, the fifth to the seventh are equal in length, but increase in breadth, terminal joint as in male. The abdomen is more elongate, and, the terminal four or more segments being exposed, is pointed.

* *Gardener's Chronicle*, 1874, p. 384.

Zealand," read on the 6th June, 1878, like McGibbon, was also silent. So in October, 1883, and again in 1887, he expresses no opinion in reference to its original habitat. Professor C. V. Riley, however, writing in March, 1879, remarks: "It is an Australian insect, apparently Dorthesia Characias, *Westw.*"—*i.e.*, an insect which has never been recorded as having been met with in the Australian colonies, and is a native of quite a different region. And again, in a letter to H. Goss, relating to California as the scene of its destructive habits, he states, "into which country, as well as New Zealand and Cape Colony, it has been introduced from Australia."* J. H. Comstock, in a report dated June, 1881, writes: "It seems probable that it is an Australian species." Professor T. Kirk, in September, 1885, states that, "it was supposed to have been introduced from Australia, but it is not a native of that continent, and in all probability has come to our shores with imported citrads from the Fiji Islands or California." The Hon. P. L. Van Der Byl, in December, 1885, remarked, concerning the so-called "Australian bugs": "They were introduced into our colony through the Australian blackwood;" and Mr. E. J. Dunn, 29th June, 1886, writes: "About twelve years ago it was noticed for the first time in the Botanical Gardens, Capetown, and most probably arrived there from Mauritius with plants sent to the Botanical Gardens. . . . . . I wrote some weeks ago to the Agricultural Department, Victoria, urging that every precaution should be taken to prevent its introduction, as there was great risk of its being brought from Mauritius."† Finally, Mr. F. S. Crawford, of Adelaide, has stated that "he is sure that it is not a native of that part of South Australia."

We have, then, Australia, Fiji, California, and Mauritius as claimants for the honour of having given birth to Icerya Purchasi. No wonder then, as we learn from Mr. F. Crawford, the question of its native country should exercise the minds of Ormerod and other European economic entomologists.

A clue to the native country of any vegetable-eating insect like this Icerya is given by considerations relating to the natural home of the plants which it affects, or to the locality in which its enemies permit it to maintain equilibrium, with relation to themselves, in the balance of nature.

The parasites of coccid insects have been so little investigated that the absence of any mention of them as attacking Icerya Purchasi, by those writers who have dealt with this pest, is a negative evidence as to their existence, in the country which these writers have had in view, of very little value. Exception, however, must be made in the case of America, in which country L. O. Howard's "Report on the Parasites of the Coccidæ" plainly indicates that far more attention has been bestowed there on this important subject than anywhere else. And yet this report does not indicate the existence of any insect parasitic there upon the "Cottony Cushion Scale." When an alien insect, too, has established itself in any country for a length of time, though at first free from their attacks, those parasites which previously have lived on whatever allied insects the fauna of that country may present, will eventually develop a taste for the new comer, and the sooner in proportion to the nearness of this alliance, or to extent of the previous range

* "*Nature*," 20th March, 1887, vol. 35, p. 453.
† Melbourne *Argus*, August, 1886.

of variability in the diet of these parasites. We have no evidence that in 1869 the Icerya Purchasi occurring about Brisbane was subject to the attacks of the same parasites which now feed at its expense here, or to those of others. In Adelaide this pest, on introduction, spread with alarming extent at first, but was subsequently so parasitised that the discovery of a single living specimen became a matter of difficulty. (F. S. Crawford.)

The probability of Mauritius being the original home of the Cottony Cushion Scale may be dismissed on consideration of the following facts:—(1) No mention has ever been made of Icerya Purchasi, or any insect answering to its description being found there, although Guérin Meneville and others have paid especial attention to the coccids of that island. (2) The only one who, as far as we can learn, has suggested Mauritius in this light, Mr. E. J. Dunn, has in his account of the Cotton Cushion Scale and its ravages,* related, as if connected with the subject, the destruction produced by quite a different insect, and one which does occur at Mauritius—*i.e.*, the Dorthesia Seychellarum, *Westw.*—made known thirty years previously.†

With reference to Professor T. Kirk's suggestion as to the Fiji Islands we may remark as follows:—If the insect occurred there it is more than probable that, as in every other country where it has discovered itself, it would attack citraceous trees, and yet the fact remains that J. P. Storck, who wrote on the orange cultivation in Fiji, and incidentally mentioned the insect enemies of that tree, does not refer to its occurrence there.‡

With regard, then, to the claim put forward on behalf of Australia—Did the Cape receive the insect from this source? We have the fact recorded that it "appeared (there) first on a specimen of Acacia meloxylon—an Australian tree, that species of Acacia of Australian types§ were its preference," and that "Coccoloba platyclada (a Solomon Islands shrub) and Pittosporum tobira (a Japanese shrub) were covered with it."—*J. McGibbon* || If introduced, then, from Australia the probability of this happening in connection with the transmission of Acacia melanoxylon—the black wood of Australia—would on hasty consideration appear to be very great; but we submit (1) this probability does not seem to have occurred to Mr. McGibbon. (2) Acacias grow so readily from seed, and their seeds have such enduring vitality, that it is the almost invariable practice to forward seeds and not young plants in supplying the demands of cultivators especially in parts of the world remote from Australia—and especially has this been in practice in the case of Acacia melanoxylon. It is scarcely likely, then, that the Capetown Botanical Gardens received young Acacias from Australia, but most probably the seeds of these plants were sent them. The Icerya could not have been transmitted with the seed.

We have still to refer to Professor's Riley's positive assertions that "it is an Australian insect," and that California, New Zealand, and the Cape all derived the pest directly or indirectly from Australia, and that

* Letter dated 2·th July, in Melbourne *Argus*, August 1886.

† *Gardener's Chronicle*, 1855, p. 836. Article by J. O. Westwood.

‡ *Vid.* "Treatise on Orange Culture," by G. E. Alberton, 1884, p. 71.

§ Not necessarily Australian species of Acacia. (H.T.)

|| *Gardener's Chronicle*, 1874, p. 384.

as far as California is concerned "it has evidently been introduced (probably on the Blue Gum or Eucalyptus)."* Neither in Australia—where so many species of Eucalyptus are indigenous—nor in New Zealand—where they have been so extensively introduced, has Icerya Purchasi been reported as occurring on any species of this immense genus. We have, however, seen it at Brisbane on young plants of one species, E. microcorys. Professor Riley writes, "It will be naturally partial to Australian trees" (this will be so if his assertion as to its original habitat is correct), and continues, it "shows a preference for Acacia, Eucalyptus, Orange, Rose, Privet and Spiræa"†—*i.e.*, for trees, the majority of which are quite foreign to the Australian flora, two are not exclusively Australian by any means, and the remaining one is co-extensive in its distribution with the whole Australian region. Reviewing the plants as yet recorded as being affected by *Icerya Purchasi* (vid. p. 53) we find that the Australian and Asiatic components of it are—excluding those plants generically represented in both continents, as 4 : 9—at the very lowest computation (*i.e.* omitting those plants mentioned by Mr. Dunn); and the exclusively Australian species amount to only five, two of which belong to genera not peculiar to that flora. Regarding the plants in Australia on which Icerya has been met with, we find that they amount to thirteen. Of this number, four plants belong to exclusively Asiatic, and two only to exclusively Australian genera; and four to exotic species, and three only to endemic species of genera common to Asia and Australia.

Its Eastern Asiatic facies appears very pronounced, and it is a fact not without significance that some years prior to 1869 when, as we have seen, the Cottony Cushion Scale was first noticed as occurring in the neighbourhood of Brisbane, extensive exchanges of living plants were being effected between this city and the Eastern Asiatic countries—China and Japan. Did not California, too, negotiate similar interchanges prior to 1868, when it is supposed the Icerya Purchasi first made its appearance in that State.

Black Scale, No. 1 (*Lecanium hesperidum*).

This Lecanium, which is so common on a great number of garden shrubs about Brisbane, and less frequently on the orange,‡ is much flatter than is the Black Scale, No. 2—Lecanium oleæ, neither has it the ridges which are so conspicuous on that insect.

The Queensland insect presents the usual characters which are assigned to this almost universal pest, whether it occurs in Europe, India, America, or New Zealand, and it has been written of at least since the time of Linnæus (1735).

The following account of the insect is given by E. T. Atkinson.§ It has the evident merit of having been compiled with the aid of Comstock's description|| :—

"*Young Insect.*—Flat, long, oval, reddish-brown; abdominal cleft visible; antennæ with six joints, the third longest, the fifth having the

* *Vid.* Report Department of Agriculture, Washington, 1878, pp. 208-9.

† *L.c.*, p. 208.

‡ It may be observed here on the three cultivated varieties of Mango, amongst other economic plants.

§ "Insect Pests belonging to the Homopterous Family Coccidæ." Journ. As. Soc., Bengal, vol. lv., p. 282; Calcutta, 1886.

|| Report of the Entomologist. Rep. Depart. Agric., Washington, 1880, p. 335.

appearance of two soldered together, the last with a few hairs; tibiæ and tarsi, of about equal length; the upper pair of digitules long; the lower short and narrow; the abdominal lobes end in two very long setæ.

"*Adult male* not known.

"*Adult female* varying in shape from a regular ellipse to nearly circular, elongate, flat, yellow inclined to brown on the disc, often dark; smooth, shining with a fringe of small hairs not very close together; sparingly punctured on the disc;* after death, the border often becomes wrinkled radially for a narrow space. The antennæ are present and are 7-jointed, 1 and 3 joints thickest, 4 and 7 sub-equal in length, and 3 a little shorter, rest shorter and sub-equal. Feet moderately long, coxæ thick, femora moderately large and about the same length as the tibiæ, which are thinner; tarsi still thinner ending in a claw; upper digitules rather long ending in a knob; lower pair about twice as long as the claw and very broad. Abdominal lobes cordiform; anal ring surrounded by six long hairs. Length 3-4 mm."

Habits.—This scale insect until it is fully grown is quite competent to shift from any position it has once taken up, and this capability for movement is mostly exercised at night time or when the plants which it has infested happen to be dying. It occurs on every part of the tree which it has settled on, and is often observed on the under surface of leaves when its attacks are extended to these organs.

In Queensland, as in New Zealand (Maskell), it is probably always viviparous, and seems to breed all the year round, its rate of increase being very great. Maskell records the fact that a female examined in the spring contained 93 embryos, and there are also probably several generations during the year.

Nature and Extent of Injury.—Diverting the sap of the part which it has infested, from its proper destination, its first effect seems to be to check the growth of the plant, and this is especially noticeable, since it seems particularly to affect the most recently developed shoots. Like Lecanium oleæ it is one of those scale insects which, as Mr. Maskell has shown ("Scale Insects," Wellington, 1887, chap. III, pas.), excrete a "honey dew" by means of an exsertile tube, emanating from the ano-genital orifice. This honey dew falling on the surface of any leaf which happens to be beneath that on which the Lecanium is fixed accumulates and forms a coating upon it. Being of a saccharine nature it supports microscopic fungi of different genera and species, and of a very dark brown or black colour. These are the components of the black sooty substance which covers any plant which the Lecanium happens to infest.† The nature of this substance, as well as the injury which its presence occasions, will be further related when we come to treat of *fumagine*, the name by which it has been designated. (Vid. p. 145.)

Introduction.—The history of the introduction and spread of insect pests into new countries is often lost sight of; nevertheless it affords a subject for important consideration. We do not know the time when the Queensland fauna was first enriched with the addition

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* Lecanium oleæ, the other orange Lecanium mentioned in this Report, has its skin filled with numerous oval or round cells of microscopic dimensions.

† The reader is referred to Maskell's very careful summary, both of his own observations and those of others, in a lesser degree.

of this scale insect: but perhaps the history of its spread in Australia, if known, would be found to be only a repetition of that which characterised its invasion in Europe. Accordingly, though described as long ago as 1735 as being found there, it had in 1852, as Mons. J. B. Robineau Desvoidy relates, only hitherto been recorded as occurring on plants grown under glass; but he then had to report the occurrence of this insect in the open air on orange trees at Nice. And after making this statement he adds, "Ces insectes ont quitté leur prison; sous les climats favorables, ils ont retrouvé en plein aire les arbres de leur véritable patrie; la nature a repris ses droits."*

Remedies.—(*Vid.* "Black Scale," No. 2, and "Peach Aphis," p. 83.)

Natural Enemies.—These are (1) birds such as White Eyes or Blight Birds (*Zosterops*, spp.); (2) a small moth—*Thalpocares coccophaga*, Meyr. (*vid.* 126); (3) a beetle—*Cryptolæmus* sp. (*vid.* p. 135, and Introduction, p. 16); and (4) a small *hymenopterous* parasite. This latter measures rather less than half-a-line in length; is dark brown; has nine-jointed antennæ, and uniformly-coloured wings.†

THE BLACK SCALE, No. 2 (*Lecanium oleæ*, Bernard).

This is the well-known insect referred to as occurring in Europe by Mons. J. B. Robineau Desvoidy, and stated by him to be "l'insect le plus désastreaux de cette époque."‡ Other subsequent writers also on insect pests have mentioned it. Of these we need only refer to J. H. Comstock§ and W. M. Maskell.|| The former of these authorities gives the following description, which will serve to define the species:—

"*Adult female.*—Dark brown, nearly black in colour; nearly hemispherical in form; often, however, quite a little longer than broad; average length from 4 mm. to 5 mm. ($\frac{1}{6}$-$\frac{1}{5}$ inches), average height 3 mm. ($\frac{1}{9}$ inch). Dorsum with a median longitudinal carina and two transverse carinæ, the latter dividing the body into three sub-equal portions; frequently the longitudinal ridge is more prominent between the tranverse ridges than elsewhere, thus forming with them a raised surface of the form of a capital H. The body is slightly margined; outer part of the disk with many (18-30) small ridges which extend from the margin half way up to centre of dorsum. Viewed with the microscope the skin is seen to be filled with oval or round cells, each with a clear nucleus; the average size of the cells being from ·05 mm. to ·06 mm. in length, while the nuclei average ·02 mm. in diameter. The antennæ are long and 8-jointed, the two basal joints short; joint 3

* "Compt. Rend. Hebdomadaires des Séances de l'Acad. des Sciences." Paris, 1852, T. xxv., p. 185.

† The position of this insect amongst the *Chalcididæ* is uncertain. It may be readily distinguished by the remarkably ribbed condition of the joints of the antennæ. These organs are nine-jointed (apparently ten-jointed in one sex), and rather flattened; the first joint is small and short; the second joint (scape) fusiform, and rather long; the eight succeeding joints (except fourth, which is slightly longer than the third) gradually decreasing in length and in breadth. Antennæ thickened towards end, but scarcely clubbed; the last joint ovate, obtuse; at their origin they are about half the distance between the eyes apart. From the third onwards, the joints support prominent narrow ribs which end in blunt teeth; there are about twenty of these on each joint, those of three last are continuous along the joint. The abdomen is ovate, the thorax is well clothed with black hair above, the wings are uniformly pubescent. This insect is common at Brisbane.

‡ Comptes Rendus, T. xxxv., p. 184. Paris, 1852.

§ "Report of the Entomologist—Report of the Commissioner of Agriculture," 1880, pp. 336-337.

|| "An Account of the Insects Noxious to Agriculture and Plants in New Zealand." Wellington, 1887, p. 82.

longest, joints 4 and 5 equal and shorter, joints 6 and 7 equal and still shorter, joint 8 with a notched margin and almost as long as joint 3. Legs rather long and stout, the tibiæ being about one-fifth longer than the tarsi. The anal ring seems to bear six long hairs."

Occurrence.—At Toowoomba it occurs on the young branches, leaf stems, and less frequently the leaves themselves of orange and all other citraceous trees, including even the citron and shaddock; and in the Brisbane District it is equally well distributed. A young plant when subject to the presence of this pest will, if left alone, succumb to its influence. The worst feature connected with it is that, as with other allied scale insects, black sooty fungi, affording a condition called *fumagine*, are invariably associated with it (Vid. *s. v.* "Fumagine," p. 145).

As in other countries, so in Queensland, this pest does not confine itself to injuring orange trees, but may be met with on many shrubs, in our gardens especially. In New Zealand it is not yet reported as attacking orange trees, and in Europe, as its name implies, it especially affects the olive. In Toowoomba we have found it in two instances on peach trees, and on one occasion on a passion fruit vine.

Habits and Increase.—During the early stages of its life this scale insect may be observed shifting its position on the branch which supports it, and when it is almost fully grown will even move slightly, especially at night, when the wood on which it has fixed itself is becoming dry.

Mr. Comstock remarks that the development of this species is very slow and that there is probably only one brood during the year.

Remedies.—Remedial measures must not be restricted in their scope to clearing away the attendant fungus. Many substances will accomplish this and yet leave most of the scales on. It is desirable also that the eggs be destroyed together with the parent insects. Of the less costly remedies, or those which are not so powerful as to act injuriously on the tree itself, we may dismiss lime, lye, salt, sulphur, lime with sulphur and soot. Gishurst compound in warm solution, repeatedly used, and a hot solution of soap (¼lb. to gallon of water), the former applied with brush and the latter with a cyclone or other nozzle attached to a force-pump or syringe, are remedies which are much extolled. The best remedy, however, will be found in the emulsion made of kerosene and milk or kerosene and soap (*vid.* "Peach—Aphis," p. 83) and applied as the simple soap solution.*

Mr. Elwood Cooper, writing from Santa Barbara, California, highly recommends the use of *Pyroligneous Acid*, diluted with half its volume of water, applied as a spray. He however mentions its price (75 cents. per gallon in California) as being an obstacle to its general employment, but expresses the opinion that it might be manufactured and profitably sold for a much "lower figure" than that which he quotes. In treating of this scale insect he also makes the following statement regarding the use of *infusion of tobacco*:—

"A decoction of tobacco is simple, inexpensive, and, if properly applied, an effectual remedy for every class of insect pests that I have come in contact with. Forty pounds of good strong leaf tobacco, thoroughly boiled in water, will make about eighty gallons. This can be thrown upon the trees with a garden syringe (force pump with spray nozzle, *vid.* Appendix),

* See also on use of Resin Compound (under "Mussel Scale," p. 40).

but it is necessary that the decoction should be kept, while using it, at the uniform temperature of 130 degrees. Hotter than this will destroy the embryo fruit; less hot, less effectual. I would recommend four applications each year until the orchards are entirely free from insects. Every orchardist must grow his own tobacco, which he can do in a small way if he attends to it properly, at a cost of two cents per pound. One acre will produce 4,000 pounds."*

Natural Enemies.—(1) The little "white eyes"—different species of Zosterops—have been observed at Brisbane feeding on an allied and equally destructive insect *Lecanium hesperidum*, and there is no doubt that these, and perhaps other entomophagous birds, help to keep down the "black scale."

(2) A *moth* (*Thalpocares coccophaga*, Meyr.).—Both at Toowoomba, and Brisbane too, we have noticed amongst these Black Scales, and generally in the angles formed by the branches on which they feed, what are usually described by gardeners in both districts as "extra fine specimens" of the pest. Examination, however, of these will soon reveal the fact that they are lepidopterous grubs which have clothed themselves with a dark covering, and that this is interwoven with and covered by the black remains of dead Lecanidæ. Thus ensconced these grubs do from time to time consume the scale insects, and we have seen a tree almost stripped of the latter by their agency. This caterpillar changes into its chrysalis state in or near the position where it was first found. After a certain number of days from the chrysalis there emerges a small moth having these characters:—It is rather small, having an expanse of wings measuring from nine to ten lines. The forewings are elongate-triangular with the anterior border slightly concave, the apex round-pointed, and the hind margin strongly rounded and oblique. The head is pale yellowish-brown coloured, the body and limbs grey irrorated with white. The hind wings are brownish (fuscous) grey, with yellowish white bases. The fringe of the forewings is fuscous-red, that of the hind wings is grey, and in both cases tipped with white.†

(3) A small *hymenopterous* brown insect having a square midbody, cordate hind body, very large black eyes, twelve-jointed antennæ, and wings crossed by three blackish bands.‡

(4) A small beetle, *Cryptolæmus sp.*, *vid.* p. 135, and Introduction, p. 16.

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* First Report of the "Board of State Horticultural Commissioners of California," p. 39, Sacramento, 1882.

† This belongs to the family Noctuæ. It was first detected, at Sydney, by Mr. G. Masters, who established its singular relationship to a Lecanium injurious to Macrozamia, and has been described by Mr. Meyrick. *Vide* Proc. Lin. Soc., N. S. Wales, 2nd Ser., vol. i., p. 10.

‡ This insect belongs to the section *Encyrtidæ* of the family *Chalcididæ*, and possesses the following characters:—Testaceous; the antennæ are widely separate, twelve-jointed. First joint very small and short, testaceous; second joint (scape) fusiform, testaceous; third to ninth (*i.e.*, funiculus) gradually diminishing in length and increasing in breadth, first five joints fuscous, and succeeding two uncoloured. The joints of the funicle gradually widening to form the three-jointed club, which is fuscous. Thorax quadrate. Abdomen sessile broadly ovate; ovipositor stout. Forewings crossed by three broad bands of dark pubescence, one occupying outer end, one a short distance from the base, and the third (narrower one) intermediate and more or less united with the outer one; about twelve bristles along the costal edge. Hind wings uniformly pubescent. Spurs on hind and middle tibiæ well marked, especially latter, which are very long and stout. Found at Brisbane.

White Orange Scale (*Chionaspis citri*, Comstock).

This scale is well known in New South Wales orangeries, and is plentiful on citraceous trees, in at least the Brisbane district, of this colony. Beyond Australia it has been noticed in New Zealand, whither it is now imported on Sydney oranges. W. M. Maskell, our authority for the New Zealand habitat, adds that it is apparently an importation from America,* in which country it had been observed in 1880, in Louisiana (Comstock). It is to be met with right up to the foot of the Toowoomba ranges, and though rare in the immediate neighbourhood of the town itself, having only as yet been observed by us in the garden of Mr. Gregory, of Drayton, it is common at no great distance from it, specimens having been forwarded from Allsprings, Koojarewon. It occurs on the branches, leaves, and fruit, and seems to attack indifferently all plants of the citrus family. The Allsprings specimens had, as associates on the same twigs, three other scale insects, viz., the Red Scale (Aspidiotus coccineus); the Long Mussel Scale (Mytilaspis Gloverii); and Lecanium Oleæ. The female scale is of a blackish-brown colour, of elongated form, narrow and pointed at one end and, when occurring isolated in positions where its development is unhindered, has amedian central ridge. It measures about a line in length. The male scale is much smaller, not exceeding from $\frac{3}{100}$ inch to $\frac{1}{25}$ inch in length. Its sides are nearly parallel, and except at one end, where there is a dark spot, its colour is snow white.

According to Maskell, its detailed description is to be found, as given by Comstock, in the Second Report, Department of Entomology, Cornell University, 1883.

As this description is not accessible to us, and the work in question is very difficult to obtain, we append the following definition of the characters presented by Queensland specimens of the insect †:—

Scale of Female.—The scale of the female, or, rather, the secreted portion of it, is of a dirty blackish brown colour. The first skin is light yellow, and the second is darker; the scale is narrow at the anterior end, and widens backwards from about the middle of the second skin. There is a longitudinal mesial dorsal ridge extending, in specimens which have developed under favourable circumstance, the whole length of the scale, or confined to that portion only which is covered by the two skins. The total length averages about ·075 inch, of which ·02687 inch is occupied by the two skins, the first measuring ·00937 inch.

Female.—The body of the female is of elongate form. The segments of the body are more or less well defined. The four last are armed with spiniform plates, and the remaining segments are unarmed. The last segment presents the following characters:—The *spinnerets* are undeveloped. There are three pair of *lobes*, of which the central ones only are serrate. The median lobes are terminally rounded, and

* "An Account of the Insects Noxious to Agriculture and Plants in New Zealand—the Scale Insects." Wellington, 1887, p. 54.

† "Those given by Maskell himself (N. Z. Trans., vol. xvii., 1884, p. 23, and "Scale Insects," 1887, p. 54) are scarcely sufficient for the recognition of the insect with certainty, and what portion of Comstock's description of *Chionaspis Euonymi* (Report, Comm. Agr., 1880, pp. 313-14) applies to this insect cannot be assigned to it, here, in the absence of the Cornell University publication.

after almost meeting in the centre of their length, diverge posteriorly; the second and third lobes of each side are deeply incised, each being divided into two, not greatly unequal lobules, having rounded free borders. The lateral margin of the segment, anterior to the third lobe on each side, is divided into four lobes, which progressively increase in size, and have serrate margins. Opposite each of these, as well as opposite each of the two portions of the second and third lobes, is a horse-shoe shaped pore. The *plates* are slender, simple, and tapering; those on the lateral margin of the segment are the largest. There are two plates lateral of each of the first, second and third lobes, and a pair about midway between the third lobe and penultimate segment. There are five transversely elongated pores on each side, the 1st opposite interval between the first and second lobes, 2nd and 3rd opposite the incisions in the second and third lobes, 4th and 5th opposite the two first impressions in the edge of the segment anterior to the third lobe. The penultimate segment, and last segment, are connate at the margin of the body. This segment bears three plates, and the two segments anterior to it bear usually seven and eleven plates respectively.

Scale of Male.—The scale of the male is white, tricarinate, with the exuviæ light yellow or brown. Length, ·03 to ·04 inch.

Male.—Yellow, with darker yellow thoracic band, but with no other special marks. Wings milky white. Eyes purplish black (by transmitted light). Antennæ, with large joint, rather enlarged, and suddenly attenuated. Total length, including style, ·028289 inch; length of style, ·007657 inch.

Natural Enemies.—(1) The caterpillar of a small moth.—On the surface of the bark, already speckled with the snow-white scales of the male Chionaspis—and amongst which will also be found the less conspicuous blackish female-scales, may occasionally be noticed patches not infrequently some inches in extent, uniformly covered with much finer, chaffy-white also, material. This last, on examination, will prove to be nothing other than fragments of the scales of the Chionaspis, which have been woven on to the surface of a webby substance of close texture. This web lies almost contiguous to the surface of the bark, and on lifting it the tiny tricarinate male-scales will be seen to be, as it were, mown down to their base of attachment on the bark, and the scale insects, which they had protected, gone. A tiny caterpillar may be found engaged in the operation, or if not—as usually happens, in some bark depression at the edge of the web area, in a cocoon of white silk, in the exposed outer surface of which fragments of bark debris have been woven, a small brown chrysalis.

(2) A fungus, Microcera rectispora, *Cooke*—highly interesting as occurring in this connection. On and amongst the Chionaspis scales will often be noticed groups of small brown rounded bodies with little masses of white fibrous material amongst them. These appearances are the indication of the presence of a parasite belonging to some genus, Microcera, as does the fungus of the *Red Orange Scale.* It, however, differs from the latter in general appearance—in colour, shape, and also in the position, with respect to the scale, in which it is found. It does not as in the case of its congener, M. coccophila, arise almost exclusively from the border of the scale, but is found growing erect on its surface and on parts around the scale. The fungus, or

rather "receptacle" (*stroma*) is composed of compacted threads; it is globose with a short broad neck (pedicel); in colour it is light brown with darker coloured rugosities. With age it resolves itself into its component white threads (the above-mentioned white fibrous material). The spores of the fungus terminate these threads, and are characteristically straight. Hence the specific designation *rectispora*.*

Remedies.—Vid. "Black Scale, No. 2," p. 125.

RED ORANGE SCALE (*Aspidiotus coccineus*, Genadius).

This scale is also known as the "red scale of California,"† the latter State having derived this pest from Australia. It also occurs in New Zealand,‡ which has almost certainly been infected from the same source; oranges, on which are Chionaspis citri and it, being constantly sent from New South Wales to that country (Maskell). Australia itself probably received it from Europe. It is a very common pest in, at least, the southern part of this colony, where it infests not only citraceous plants, but other kinds also, including the mulberry, which succumbs to its attacks. It is especially prevalent, wherever there are oranges, in the Toowoomba District.

Symptoms.—It occurs equally on trunk branches, leaves, and fruit. Every accessible spot on the bark of infected trees is at times occupied by it—a complete encrustation being thus formed. Oranges —if the scale has settled upon them in any quantity—after gathering, become disgustingly black with its dead and discoloured remains; and, previous to their ripening, their natural bright-green colour gives place to a pale-yellow, their growth is retarded—they do not reach their full size, and they may even fall from the tree. When the leaves are attacked by them, they exhibit conspicuous yellow-green spots, the centres of which are occupied by the scale insects themselves, and either the assimilating power of the foliage is much diminished, or worse, the leaves are shed, and by both of these events is the health of the tree considerably impaired. When on the bark itself their presence is not quite so conspicuous, owing to a certain harmony of colour being maintained, but the injury which they occasion, when in this situation, is none the less.

Full descriptions of the insect are quite accessible. Maskell has described it§ and Comstock|| also, both more or less fully, and in Australia itself, Mr. Frazer S. Crawford has made most interesting observations concerning it.¶ Each of these scientists has investigated the insect and its ravages without any knowledge of his fellow-labourers' concurrence in the same work or of the existence of any

* This fungus, having been forwarded, by request, during the progress of this inquiry by F. M. Bailey to M. C. Cooke, has been pronounced by the latter to constitute a new discovery. It is described by Messrs. Cooke and Massey as follows:— *Microcera rectispora*, Cke. and Mass. Sporodochiis subsphæroideis, subsessilibus, primo rubellis, demum albidis, conidiis elongato fusiformibus, utrinque acutis 7-9 septatis, hyalinis, 150-200 x 10 micro. mil. Sporophoris brevibus, tenuibus, furcatis, hyalinis. *Grevillea*, September, 1887, p. 4.

† In contradistinction to the red scale of *Florida*—Aspidiotus ficus, Riley.

‡ Maskell. "Scale Insects," p. 42, and N. Z. Trans., vol. xi., 1878, p. 199.

§ N. Z. Trans., vol. xi., 1878, p. 199; and "Scale Insects," 1887, p. 42-3.

|| "Report of the Commissioner of Agriculture," Washington, 1880, pp. 293-5; and Canad. Ent., vol. xiii., p. 8.

¶ The "Round Orange Scale," paper read before the S. A. Gardeners' Improvement Society, May 6th, 1882, plate.

previously recorded facts concerning the subject. Maskell named it Aspidiotus aurantii; Comstock, Aspidiotus citri ; and Crawford, Chrysomphalus aurantii.

Description.—It may be recognised by the following description of the *Scale of the female.* This is circular, almost flat, about $\frac{1}{11}$ inch in diameter. It has a nipple-like prominence in the centre. In colour it is light gray, and quite translucent, its apparent colour depending on that of the insect beneath, and varying from a light greenish-yellow to a bright reddish-brown, the central third is as dark and usually darker than the remainder of the scale (Comstock). In addition to the ordinary dorsal scale this Aspidiotus has the ventral scale, or that interposed between its body and the surface of the plant on which it has settled, developed to an unusual extent, and so almost enclosing the cavity of the puparium.

Scale of male.—"The scale of the male resembles that of the female, except that it is only one quarter as large, and the posterior side being prolonged into a flap which is quite thin." (Comstock.)

Extent of injury inflicted.—We have no data by which to represent the actual money equivalent of the damage for which this insect is responsible in Toowoomba or other districts of the colony; but one may often see young trees whose fruit-producing power is completely held in abeyance owing to its presence. Mr. Comstock, however, states—"This insect spreads quite rapidly; and from what I have seen of it I believe that it is more to be feared than any other scale insect infesting citrus fruits in this country. As illustrating the extent of its ravages in Australia, Dr. Bleasdale told me of a grove of thirty-three acres which nine years ago rented for £1,800 per year, and for which three years ago only £120 rent could be obtained."* Previous to 1880 this same scale had occurred at Chios in such abundance as to destroy the orange trees there, as Mr. McLachlan informs us.†

Remedies.—*Vid.* "Black Scale, No. 2," p. 125.—Owing to the fact of the ventral scale being developed to so unusual an extent, and the insect therefore possessing a large development of secreted matter impervious to most insecticidal fluids, except, only perhaps, kerosene, the red orange scale is especially difficult to extirpate. Dr. J. Bancroft, of Brisbane, has been in the habit of using a brush composed of steel wire for the purpose of clearing the bark of infested trees.

Natural Enemies.—1. A *fungus*, Microcera coccophila, Desm. This fungus which really lives at the expense of the Aspidiotus coccineus is usually regarded as a pest itself. Its fungus nature is not even suspected, indeed it is even looked upon as a coccus insect and designated the *Scarlet Scale.* The following is its mode of occurrence and characteristic appearance. When orange trees are infested with the "red scale," and especially when their branches also are black with the *fumagine* consequent on the presence also of the Lecanium oleœ, there may be observed small irregular rose-red bodies. These are especially noticeable on the blackened boughs. But when in this position, but more especially when situate on the leaves, it will be seen that these are closely connected with the present scale insects. In

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* Report of Entomologist, U.S. Department of Agriculture, Washington, 1880; page 295.

† *Gard. Chron.*, 1880, p. 665.

fact they are small conical tufts which emerge, often to the number of three or four, from the margin of the "scales," or, when the scales themselves are concealed by the growth of the *fumagine*, these tufts appear to arise erect and stalked immediately from the boughs and independent of such origin. Microscopical examination shows that the tufts are composed of minute nearly simple threads matted together and that these threads terminate in narrow and sharp-pointed low crescent-shaped bodies, which are the spores of the fungus. This fungus is well known in Europe as the "Coccus microcera," and has previously been noticed in this colony by Mr. F. M. Bailey on a species of Coccus which infests the lemon. It is shortly described in the "Synopsis of the Queensland Flora" of that author, and more fully by M. C. Cooke, who illustrates the species by means of a figure representative of its appearance when highly magnified.*

(2) *A small* oval-shaped hairy *beetle* measuring $1\frac{1}{12}$ inch in length, which has the wing covers (elytra) brownish black, and the remaining parts light brown. This insect is closely allied to the rather larger beetle which feeds upon the Circular Black Scale, being like it a *Rhizobius*.†

CIRCULAR BLACK SCALE (*Aspidiotus ficus*, Riley).

There can be no doubt but that the small circular reddish-brown or black (fig-coloured) scale, with light-coloured central area, not infrequently found on orange trees about Brisbane, is the Aspidiotus ficus, *Riley*, a scale hitherto only observed as occurring in Americaa and the West Indies, and first described by Ashmead‡ under the name Chrysomphalus ficus, but afterwards by Comstock§ as Aspidiotus ficus.

The latter's observations are so carefully recorded and so well apply to our own scale insect that for the purpose of facilitating recognition—and this can only be effected with certainty by reference to minute details, his description of the female scale insect, only, may be profitably introduced here. This is contained in his report to the United States Commissioner of Agriculture, and is that referred to in the last of the above references. It is as follows:—

"*Scale of Female.*—The scale of the female is circular, with the exuviæ nearly central; the position of the first skin is indicated by a

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* "Handbook of British Fungi," vol. 2, p. 556.

† The following is a description of the insect:—*Rhizobius*, sp. Elytra and an ill-defined blotch behind centre of fore-border of prothorax brownish-black. Rest of prothorax, head, whole undersurface, limbs and mouth organs, testaceous. Confusedly punctured, densely clothed with a rather long pubescence; erect hairs also, sparsely distributed on the elytra. Head immersed in prothorax to a little beyond hind border of eyes. Front very broad and even; labrum entire; eyes prominent and coarsely facetted. Prothorax more than twice as broad as long, fore-border shallowly excavated, hind border produced in centre and slightly hollowed out on each side, sides bordered and regularly arched, anterior lateral angles rounded off, on each side a group of large contiguous punctures. Elytra with very broad epipleuræ extending to hind border of third abdominal segment, suddenly contracted behind. Prosternal ridges well defined, regularly inclined, and meeting in very open obtuse angle. Abdominal plates apparently plane, nearly reaching hind border, but not extending to lateral one of first segment; its hind margin regularly arched. First abdominal segment rather coarsely punctured. Claws shortly appendiculate. Length slightly exceeding one line.

‡ American Entomologist, 1880, p. 267.

§ Canadian Entomologist, vol. xiii., p. 8; and Report of the Commissioner of Agriculture, Washington, 1880, pp. 296-300, p.l. iii. 2; xii. 2.; xiii. 2.

nipple-like prominence, which in fresh specimens is white. The part of the scale covering the second skin is light reddish brown; the remainder of the scale is much darker, varying from a darkish reddish brown to black, excepting the thin part of the margin, which is grey. When fully grown the scale measures 2 mm. ($\frac{1}{12}$ inch) in diameter. In some specimens the part covering the exuviæ is depressed, and when the scale is removed from the leaf and viewed under the microscope with transmitted light, the exuviæ, which are bright yellow, show through this part (occasioning an appearance which, with Mr. Ashmead, suggested the name Chrysomphalus (golden navel) for this scale.)

" *Female.*—The body of the female is nearly circular; it is white marked with irregular yellow spots (but the fatty contents of the body are usually so copious as to cause the little insect to appear wholly yellow). The last segment presents the following characters:—

" There are four *groups of spinnerets ;* the anterior laterals consist each of about eight, and the posterior laterals of about four.

" There are three pairs of well developed *lobes.* The first and second lobes of each side are abruptly narrowed towards their posterior extremities on the lateral edges, at about one-half their length; the third lobe is narrowed by a succession of notches on its lateral margin; all the lobes are widened slightly towards their bases on their mesal margins.

" The *lateral margin* of the segment appears to be of the same structure of the lobes; it is serrate deeply notched two or three times, and ends posteriorly in a lobe. There are six *thickenings of the body wall* on each side of the meson. These are linear, oblong, with the anterior ends rounded, and slightly expanded, and are more or less nearly parallel with the meson. One arising from the mesal margin of first lobe exceeds it a little in length; one from the lateral margin of the same lobe extends nearly to the anus; one each from the mesal margins of the second and third lobes are about twice the length of the lobes, and with the anterior extremities further from the meson than the posterior; one from a point about midway between the second and third lobes, extends anteriorly beyond any of the other thickenings; and finally one from the lateral margin of the third lobe is short, inconspicuous, and sometimes wanting.

" Between the first pair of lobes are two wide oblong *plates*, with the distal margin of each deeply fringed; between the first and second lobes of each side are two, and between the second and third lobes are three similar plates; between the third lobe, and the one at the end of the thickened lateral margin are three large compound plates, each consisting of two long branches, which are toothed deeply and irregularly on their lateral edges. On the ventral surface near the margin of the segment are situated four pairs of *spines*, there being a spine at the base of the lateral margin of each lobe, including the lobe of the thickened margin of the segment described above. On the dorsal surface there are only three pairs of spines, none being present on the first pair of lobes; each spine is situated near the middle of the base of the lobe it accompanies."

Mr. Comstock then proceeds to deal with the scale of the male, and with the male insect itself; but the presence of the above characters of the last abdominal segment, in any specimen under examination, are alone sufficient to identify it with Aspidiotus ficus.

Development of the Insect.—The same able authority, having received specimens of these scale insects from a distant locality, placed some of their eggs on perfectly clean orange trees, growing under his immediate observation, and then noticed the development of this Aspidiotus from the egg to the adult state; following these changes through five generations. Thus he was led to conclude that sixty-six days elapsed from the time when an egg hatched until when the resulting female scale insect oviposited itself. Also that that insect passed through five generations in less than a year; the average time occupied by a single generation being a little less than seventy days. These numbers may, of course, as Comstock suggests, be modified when the Aspidiotus is living under perfectly natural conditions.

Habitat.—Mr. Comstock relates that he had not found that in the United States it occurred outside Florida. It was met with there in a single orange grove only. In this it had been first noticed on a tree imported from Havana, where it was to be plentifully met with.

Occurrence on other trees.—In Brisbane* we have met with the scale on the following plants, growing in gardens, viz.:—Atalantia buxifolia, Camphor laurel, Bean-tree (Castaneospermum), and an indigenous species of Myrtle—Myrtus Hillii.

Extent of injury occasioned.—It infests the limbs, leaves, and fruit; and is especially injurious to young trees. The effect produced by its presence is similar to that occasioned by the red scale. In Brisbane it often accompanies, on the orange, the White Orange Scale, and also Glover's scale. Mr. Comstock states (*Op. cit.*, p. 330), "The insect has multiplied to such an extent upon the trees upon which I colonized it, in my breeding-room, that nearly all of them have been destroyed."

Remedies.—If it is observed at its first introduction into an orangery, there can be no doubt that it would be a wise measure to destroy, by fire, those plants on which it occurred. The American authority is very pronounced in this view; he states: "There is no doubt that it would be a good investment for the orange growers of Florida to eradicate the pest, even if, in doing so, it is found necessary to purchase and destroy all infested trees. This could be done now easily, but if delayed a few years, the species will doubtless become permanently established. Should such extreme measures be otherwise inexpedient, and the trees large ones, recourse must be had to the kerosene emulsion" (*vid.* p. 84), since the insect is protected by a closely fitting scale, unaffected by most other insecticides. We have observed, in the latitude of Brisbane, that the eggs are hatched at the commencement of summer—in the middle of September—in the particular instance we have in view. The emulsion must therefore be applied as soon as, or shortly after, the fruit has been gathered.

Natural Enemies.—A small beetle, measuring about $1\frac{1}{2}$ lines in length and $1\frac{1}{4}$ in breadth, with its surface—which is clothed with very short greyish hairs—coloured as follows:—Head from the hind border

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* During October, 1887, we purchased in Brisbane imported American apples (a variety approaching Maiden's Blush), on the rind of which were numerous examples of this scale.

of eyes forwards and outer thirds of mid-body (prothorax) lemon-yellow; antennæ, palps, outer thirds of prothorax beneath anterior pair of limbs, feet (tarsi) of middle and hind legs and abdomen testaceous-brown; remaining parts black.*

GLOVER'S SCALE (*Mytilapsis Gloverii*, Packard).

This scale insect is common on the orange trees about Brisbane, and was forwarded from Allsprings, Toowoomba. It is often associated with the White Orange Scale and the Circular Black Scale. The following description will aid in identifying it:—

The scale of female.—The scale of the female is very much elongated, straight, or more or less curved, pointed but blunt at one end, gradually widening to the termination of the second pelicle, and then with parallel sides for the remaining three-quarters of its length, the upper surface being regularly convex. The colour is light yellow varying to dark brown with lighter, often transparent, margins, the whole scale measuring in length from 1 to $1\frac{3}{4}$ line, and has a greatest breadth of ·026875 inches. The two pelicles at the narrow end occupy a length of ·0375 inches. The lower surface is occupied by two parallel white plates extending the whole length of the scale. These have an interval between them in which the naked insect, or insect and its eggs, are seen.

Female.—The body of the female is light-purple in colour, with the last segment yellowish. In length it is ·045 inch. The characters of the last segment are as follows. The median *lobes* are well developed, but are abruptly narrowed with scarcely serrate margins. The second lobe, and the less conspicuous third one, on each side are incised. The *plates* are long, simple and tapering. Of these there are (1) two between the median lobes, (2) between the first and second lobes; (3) between the second and third lobes; (4) lateral of third lobe and about midway between this lobe and the penultimate segment. (2) and (3) are the least conspicuous. There are five groups of *spinnerets* of which the anterior group consists of five; the anterior laterals of about eleven, and the posterior laterals of five.

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* This insect is a *Rhizobius* (Group *Scymnites*), and does not appear to come within the definition of any recorded species, not excepting those recently added to the Australian fauna by Rev. J. Blackburn (*Trans. and Proc. Roy. Soc. S. Aust.*, vol. xi., 1887-8, pp. 193-209). The following are its leading characters:—Form, ovate; pubescence, even; head, prothorax, and elytra finely and closely punctured. Head immersed in prothorax to hind border of eyes; labrum entire; breadth between eyes rather more than twice the diameter of the latter; sides of epistome forming a ridge, but not concealing basal joints of antennæ; eyes entire, rather coarsely granulated; antennæ scarcely exceeding width between the eyes, third joint equal to fourth and fifth, tenth and eleventh broader than long, eleventh truncated. Prothorax less than half of breadth in length, roundly excavated in front, rounded and bordered at the sides; two halves of posterior border converging to an open angle behind; anterior lateral angles rounded, posterior angular. Elytra elevated in front opposite the humeral angles, inclined behind. Epipleuræ well defined, gradually narrowed posteriorly, and extending to hind border. Acetabulæ of prothorax closed behind prosternal ridges well defined, slightly approaching in front of acetabulæ, and meeting in an obtuse angle. The abdominal plates, about three-quarters the length of the basal segment, have their hind borders regularly arched, and are clothed and punctured as the remainder of the segment. The femora are grooved internally to receive the tibiæ. Claws with a long broad obtuse appendage.

Scale of male.—The scale of the male is similar in form to that of the female, except that there is but a single molted skin, and the scale is furnished with a transverse hinge.*

We have observed the female scale to be full of eggs in September.

Mr. Comstock states "This is a very common species on citrus trees in Florida and Louisiana. It infests the fruit, leaves and bark of the trees."†

He also gives grounds for supposing that this scale insect may have been originally derived from China, and states that it now occurs in Europe also. No mention is made of its occurrence either in India or New Zealand by those who have dealt with the scale insects of these countries.

Mr. Frazer S. Crawford‡, writing on the mischief which may be done by not stamping out at once a newly introduced pest, quotes the testimony of Mr. W. H. Ashmead, the well known entomologist (author of "A Treatise on the Injurious and Beneficial Insects found on the Orange Trees of Florida," Jacksonville, Florida, 1880), concerning this very insect, Mytilaspis Gloverii:—"In the year 1835 (date given me) it was first brought into this country on some orange trees imported from China, first making its appearence in the grove of Dr. Robinson, at Mandarin, a small town on the St. John's River, about twelve miles from Jacksonville. In a few years it had spread to the groves throughout Florida, carrying devastation and ruin wherever it went. So great was the damage done that orange-growers became discouraged, and orange cultivation was nearly annihilated. Many groves that had been yielding handsome incomes were totally destroyed. Happily, however, in a few years the scales became less numerous, and orange trees were again planted."

Now it is constantly forwarded to Australia from the Western States of the American Union. We have seen it attached to "American Apples" which were being retailed at Brisbane during October. [It has since occurred to us that this remark should apply to *M. pomorum*, p. 39.—H.T.]

NOTE.—*Natural enemies.*—There are several insects in Queensland which feed on, and thus destroy, more than one kind of coccus. Amongst them is the beetle Cryptolæmus, mentioned in the introduction to this report (*vid.* p. 16), and several "lady-birds" belonging to the genus Orcus. All these are equally voracious, whether adult or in the larval state.

(1.) *Cryptolæmus* is a small oval beetle, measuring two lines ($\frac{1}{6}$ inch) in length and one and a-half lines ($\frac{1}{8}$ inch) in breadth, having the head, the corselet, the extremity of the wing-covers, and the under surface, in-part, red; whilst the greater portion of the wing-covers above and the thorax beneath is black. The whole surface is finely punctured and thickly clothed with close greyish pubesence.§ The

* The above description is an almost verbatim reproduction of what Comstock states concerning this scale insect. "Report of the Commissioner of Agriculture," Washington, 1880, p. 323.

† *Op. cit.*, page 324.

‡ "The Round Orange Scale," paper read before the South Australian Gardeners' Improvement Society in May 6, 1882.

§ This insect has the characters mentioned by Mulsant as being possessed by his *Cryptolæmus Montrousieri*, except that the latter insect is perhaps the larger of the two. It has the general facies of the species of Rhizobius mentioned by us as being destructive to the Black Scales, Lecanium hesperidum and L. Oleæ respectively, but is larger than either. In structural characters it differs from them by possessing a prosternum unkeeled and produced forwards to cover the mouth organs.

larva is a small active grub, measuring about a quarter of an inch in length, covered above with six rows of contiguous white mealy secreted appendages.

(2.) *Orcus*, sp. The insects belonging to this genus of coleoptera are rounded, very convex, sub-hemispherical, smooth, shining beetles, which, having their legs hidden beneath the body, appear to rest flatly on the spots where they occur. They measure from rather more than $\frac{1}{8}$-inch. (3·5 mm.) to rather more than $\frac{1}{5}$-inch. (5 mm.) in length. A very common example is uniformly steel-blue with dark-purple reflections. A second species—*Orcus bilunulata*, Dej., similarly coloured, but without the purple reflections, has a large orange spot on each wing-cover. A third—*Orcus Australasiæ*, Dej., similar coloured, has six orange spots on the wing-covers. These three beetles, which reach the above-mentioned major limit of measurement, *i.e.* $\frac{1}{5}$-inch., are equally useful in destroying the scale insects of the orange; the first-mentioned being an especial enemy of the Circular Black Scale (Aspidiotus ficus), gnawing through the apex of the covering of one individual after another of this pest. There are also two species representing the smaller dimensions, one violet-coloured, the other bright-blue. Both of these have the sides of the corselet (prothorax), and under surface pale luteous. Not only are these insects, when adult, voracious feeders on scale insects, but their larvæ also are endowed with a similar appetite.

Black Orange Tree *Bug* (*Erga*, sp.)*

The Black Bug is a bronzy black insect, often measuring an inch in length, with a very short proboscis, and light coloured four-jointed feelers. It is the largest of the tree bugs which do injury to the foliage of the orange in the Toowoomba orchards, and is also to be met with throughout the Moreton district, being known to us as occurring at Cleveland, Stradbroke Island, Nundah, North Pine, and in several other localities.

It in great measure restricts its attention to the young shoots of the orange tree, and on these it crowds to the fullest possible extent, attached apparently in a very awkward position, with its broad flat back facing outwards. When disturbed, these bugs move slowly around their support or remain stationary. On being handled, like other tree bugs, they emit a pungent odorous fluid.

By inserting their short probosces into the young wood they retard the growth of the shoot on which they feed, and so hinder the free development of what were destined to become fruit-bearing branches.

The following description of the Black Orange-tree Bug will assist in distinguishing it:—

Erga, sp. Dark bronzy-brown above, reddish-brown beneath, an indistinct light-coloured line down the centre of thorax and scutellum, and a greenish band on the outer border of the coriaceous portion of the elytra. Head almost smooth, thorax coarsely coriaceously punctured, scutellum

* This insect is referred to the late F. Walker's genus *Erga* (Cat. of Hemiptera Heteroptera, pt. 3, London, 1868, p. 486), Fam. Edessidæ, as possessing many characters in common with the type of it. It, however, differs in wanting a ventral spine, "broad acute, and extending little beyond the middle coxæ." The typical species *E. roseoflua*, F. Walker, which presents very variable colours, has been procured in the Moreton Bay district.

coarsely and coriaceous portion of the elytra finely and closely punctured. Head broadly triangular, lateral lobes broad concave, rounded in front, and meeting beyond the middle lobe which has a few transverse striæ. Rostrum extending to middle coxæ. Eyes prominent, a blunt tooth in front of each, on the side of the head. Antennæ five-jointed, first joint shorter than head but exceeding it, "second joint about four times the length of the third, fourth a little shorter than the second, fifth a little shorter than the fourth" (*Char. gen.*) Two proximal joints red, three distal ones light red. "Scutellum attenuated keeled towards the tip which is rounded" (*Char. gen.*) with a light spot at each anterior lateral angle. "Abdomen with a slightly dilated connexivum which extends beyond the costa of the fore wings" (*Char. gen.*). Ventral spine reduced to a broad short tuberosity. Outer border of corium of fore wing oblique, slightly undulating; membrane translucent light-piceous "some of the veins forked." Size variable in both sexes, $\frac{7}{8}$ inch to 1 inch long.

When *young* this insect is almost regularly elliptical in shape, nearly quite flat above and of a yellow or yellow-red colour. At this period the wings and wing-covers are in quite a rudimentary state.

(The spherical glistening *eggs* are laid singly here and there upon the leaves of the orange tree.) The number of broods which occur throughout the year has not been ascertained, nor has the longevity of the insect, or the time occupied in completing the different stages in its life history.

The late Mr. J. H. Hartmann informed us (in 1887) that he had only observed the Black Orange-tree Bug in the immediate neighbourhood of Toowoomba during the last four or five years, but that he had noticed its occurrence in "Tansey's orchard," at Highfields, some fourteen or fifteen years since. The conclusion however, which may be deduced from this assertion certainly needs confirmation.

Remedies.—Such large conspicuous objects can scarcely escape detection. They may be easily taken by hand too, as they make little or no effort to escape. For the purpose of their capture it seems expedient to use a small hand net with double bag—the inner one, the shorter, tapering downwards and opening at the bottom. Into this net the bugs may be shaken or beaten by aid of a small stick held in the right hand. The inner bag will prevent the Ergas when once within the net from escaping.

Natural Enemies.—It is unlikely that the bug itself has any insect enemies, but the eggs do not probably maintain such immunity, since the special hymenopterous parasites which live within the eggs of hemipterous insects and which are known to exist in Europe occur in Australia also. The odour which the pest emits does not, however, appear to protect it from the onslaught of birds; for, as we have been informed, the Flinders Cuckoo has been known to rid an entire orange orchard, in the Moreton district, of this tree-bug.

NOTE.—The same family of Tree-bugs, *Edessidæ*, presents us further with an additional orange-tree pest, in Southern Queensland. This may be easily mistaken for the Black Bug described, since they both have the same general appearance. It is, however, distinguished from the latter by the possession of a pointed and deeply emarginate head, and hispid four-jointed antennæ, with the second and third joints channelled above. The sexual characters in the two insects are also distinct. This tree-bug, too, when immature, exhibits a well-defined black spot on the scutellum, and has broad black rings on the two last joints of the antennæ.

In habit it corresponds to the Black Orange-tree Bug.

GREEN ORANGE-TREE BUG. (*Rhynchocoris*, sp.).

This is a grass-green tree-bug, measuring ¾ inch in length, having two sharp horns extending laterally from behind the head, one from each side of the body.

Unlike the Black Orange-tree Bug the present insect seldom occurs in greater numbers than two on one spot, and is more often solitary.

The following technical description of the green bug may serve to distinguish it:—

Rhynchocoris, sp.* Elongato-oval, glossy grass-green above, lighter green beneath; anterior two-thirds of eyes, forepart of lateral thoracic spines, posterior lateral angles of the six last abdominal segments, black. Head sub-elongate, large lateral lobes coarsely punctate. Eyes black with a (green) posterior basal band. Rostrum extending beyond hind coxæ to the hind border of the second abdominal segment, tip black. Antennæ with first joint extending nearly to front of head, second joint little more than half the length of the third. Thorax with a transverse callus on each side in front, spines stout, long, and acute, with the tips slightly turned back as in *R. serratus*, Don. Scutellum extending beyond half the length of the abdomen, rounded at the tip, shallowly emarginate at sides, without callus. Pectoral keel deep, extending almost to head. Ventral spine not extending anterior to the hind coxæ, received into the notch of the keel. Hind angles of the abdominal segments forming sub-equal prominent black teeth. Fore wings extending beyond tip of abdomen leaving border exposed, thickly and minutely punctured; membrane pellucid. Length of body ¾ inch, breadth through horns of thorax $\frac{9}{16}$ inch.

Habits.—The whole series of the changes of the Green Orange-tree Bug, from the egg onwards, are undergone upon the foliage of the orange. The *eggs* are pearly white, smooth and spherical, and are deposited singly upon the leaves.

The injury which this bug occasions is due to its habit of inserting its long proboscis (suctorial apparatus) into half-grown oranges. These, on being thus dealt with, shortly fall from the trees.

Mr. Roessler stated that in some seasons he had known the yield of an orange tree to be reduced one-third in amount as a result of the attacks of this insect.

Remedies.—The measures for contending with this pest are similar to those suggested for the Black Bug (*vid.* above). By reason of its green colour, and habit of moving aside when disturbed, it may easily elude observation.

THE GREEN LOCUST (*Phanoptera valida*, Walk.).

This pest was well represented in the Toowoomba district. It is not its habit to occur in swarms, as do the grasshoppers, but to be generally distributed. As far as observation went it was found to feed on the foliage and fruit of the grape, and to gnaw the rind of oranges when still green, to such an extent as to permanently disfigure them. It was also noticed feeding on rhubarb and other plants. In the case of the grape it eats the skin of the berry, consuming an irregular portion of it, and the pulp being thus exposed parts with its juice by evaporation and so shrivels up.

* In the "Catal. of Heteropterous Hemiptera in the collection of the British Museum," Pt. II., Scutata, by Francis Walker, London, 1887, there is a species of this genus (*R. ligatus*, Erichson), referred to as occurring in Australia. We are not familiar with this insect, neither is Erichsons's description of it available for comparison. The term *ligatus*, however, does not apply to the Rhynchocoris before us.

When stationary on the plant on which it is feeding, with its deflexed wings enveloping the body, the possession of a uniform green colour, harmonising with that of the foliage, enables it often to escape observation. When disturbed its flight is heavy, as compared with that of the true grasshoppers, and is not long protracted. This insect may with facility be distinguished from any of the grasshoppers proper (*Acridida*), and especially from those elsewhere mentioned in this inquiry. Perhaps the most striking character of the Locustidæ, the family to which it belongs, is that afforded by the long fine hair-like feelers, as contrasted with the short setaceous ones of the Acrididæ. In the latter family too, the feet are only three-jointed, whilst the Locustidæ have four joints in their feet. The fore wings also of the males of these insects have transparent spots behind, near their inner bases. These spots, which are connected with stridulation—the production af a chirping sound, are absent in the Acrididæ.

Description.—This Phaneroptera was originally characterised, in 1869, by Francis Walker,* and has more recently been re-described and figured by Professor F. McCoy, F.R.S. † This last authority gives the following definition of the insect:—

Male.—Head brown, with green tinge; eyes very prominent, greenish-brown; antennæ very slender, pale brown; prothorax with a flat or slightly concave, oblong disc, sides bent down at right angles, with a strong, straight, pale-yellowish keel on each side at the flexure; rest of the surface pea-green; anterior margin slightly concave, posterior edge convex. Presternum narrow, sulcate along middle, meso and meta-sternum broader, slightly convex, with raised lateral edges, deeply bilobed behind. Upper abdominal appendages long, slightly curved upwards; lower pair very short. Legs very long, slender; femora and tibiæ with few very minute spines, proximal half of hind femora moderately thickened; anterior pair of tibiæ dilated at base for oval drum cavity; all the legs pale-brown, except thick parts of hind femora, which are green on outer side. Tegmina, or anterior wings, narrow, about two lines shorter than posterior wings when at rest; large areolets irregular, not distinctly marked, pea-green except the large triangular part of inner base, carrying the iridescent, transparent, stridulating spots, which are pale-brown. Hind wings colourless, with pale pink and green iridescent reflection; a triangular opaque, pea-green spot, two lines long, on anterior half of apex (which opaque-green portion projects beyond the tegmina when at rest); abdomen brown above, green below; tibiæ, tarsi, distal half of hind thighs, and palpi, pale brown; angle at sides of thorax, continued by inner or posterior veins of tegmina when at rest, pale yellowish. Expanse of tegmina, 3 inches, 1 line; length of body, 1 inch.

Female.—General structure and colour like male, except inner bases of tegmina which are green, and finely reticulated like the rest. Length of tegmina, 1 inch 7 lines; length of body, 1 inch 1 line.‡

Larvæ.—During the time which elapses from when the locust leaves the egg until it attains maturity it moults four times, and at the fourth moult attains its fully developed organs of flight. Previous to this the wings and wing-covers are more or less rudimentary; but in almost all other respects, except in size and in the form of the anal plates, it resembles the adult. The period occupied with these successive moults has not been observed.

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* "Catalogue of Dermoptera Saltatoria," part ii., p. 352.

† "Prodromus of the Zoology of Victoria," Decade xii. Melbourne, 1876, p. 75, pl. 119.

‡ F. McCoy, F.R.S., etc., *L. c.*

Eggs.—We are not aware that the eggs of any species of Phaneroptera or the situation in which they are placed, have been previously described. From the rudimentary character of the ovipositors it might, however, have been inferred that they were not placed, as is the case with many Locustidæ, in the ground. And this is the case, for they are laid on the tree itself. The eggs of two species of Phaneroptera were met with on orange trees in the Toowoomba district, but it could not be ascertained with certainty to which two adult insects they belonged. In case No. 1 they were flattened, and of an elongated oval form—like small mellon seeds, smooth and of a coffee-brown colour. These eggs were fastened to a branchlet, and also to the petiole of a leaf arising from it. They were placed in single or double rows, and each egg was fastened at one end to the bark and stood out from it in an oblique manner. Successive eggs in the rows were not only contiguous but were also attached in a similar sloping way. The eggs composing adjacent rows were placed alternatively one with the other. In case No. 2 the eggs, as compared with the first mentioned, were smaller in size, more elliptical in shape and black in colour. Thirteen were observed on one orange leaf, and they were disposed in a single line on the under-surface of it, extending up the midrib to the apex, and then along one side. Successive eggs in the line were almost contiguous, but they did not arise from their point of attachment in an oblique manner.

Natural Enemies.—Like grasshoppers proper the Phaneroptera are much preyed on by insectivorous birds. The eggs too, by reason of the unprotected way in which they occur on the trees are doubtless subject to the attacks of such parasites as lay their eggs in the ova of other insects. This may be concluded from what is recorded concerning an allied insect, the "Green Katydid" of the United States (*Microcentrum retinervis*, Burm.).*

Remedies.—The peculiar manner in which the eggs are placed renders them conspicuous objects; their destruction would no doubt be largely instrumental in diminishing the numbers of subsequent visitants. Since, too, the Phanopteræ feed on the tree in every stage of their existence, they also may be gathered and destroyed.

The Spotted Locust (*Ephippitytha*, sp.).

A much larger locust than *Phanoptera valida* is occasionally met with on fruit trees at Toowoomba. It is, however, closely allied to this insect, and has the same habits. In the female the expanse of the wings is quite 5 inches. The wing-covers are of a more yellowish-green than are those of P. valida, and they have the following disposition of spots:—A row of from seven to nine beneath and following the costal vein; a second row, of the same number, proceeding from the first at the base of the wing and following the hind border. In addition to these spots, the wings and wing-covers are suffused with pinkish-brown opposite the outer thirds of their fore-borders. The tibial joints of the limbs, too, have dark-brown bands, those of the hinder pair having three, and those of the two other pairs two each.

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* *Vid.* Report of the Entomologist, Agricultural Department, Washington, 1880, p. 251.

Large Brown Grasshopper (*Acridium* [*maculosum*, Stal.]).

This insect is very destructive to both the foliage and fruit of several kinds of trees. The rind of young oranges is gnawed by it, and so the fruit is permanently injured.

Description.—In addition to the generic characters given by Audinet Serville * and other authors this insect presents the following specific features:—

The Female.—The colour of the female is olive-brown above, lighter coloured beneath; a few small spots, the largest being those on the sides of the abdominal segments, cream white. Antennæ (feelers), with the exception of their basal joints, tarsi (feet), dorsum (back portion) of anterior abdominal segments, the two ridges on the external surface of the femora (thighs) of the hind limbs, bluish-coloured. The two rows of backwardly directed spines on the tibiæ (shanks) of the hind limbs red with black tips. Wings and wing-covers exceeding in length the abdomen. Wing-covers, when closed, dull brown with a few transverse, very obscure, darker blotches; veinlets light-brown—those of the outer third reddish-brown. Wings with the veins and veinlets of the anterior border reddish-brown and of the other parts nearly black; wing-membrane unspotted, suffused with purple-blue, especially near the point of attachment of the wings. Vertex of head hexagonal impunctate, front of head—between the keels—with coarse shallow punctures. Prothorax with upper profile nearly straight, but slightly arched opposite the transverse groves, and excavated along the posterior half, coarsely punctured, with three or four smooth light-coloured areas on each side, the upper two of which are sub-equal and larger than the others. Expanse of wings $6\frac{1}{4}$ inches, length of body $3\frac{1}{6}$ inches.

Male.—The male is of somewhat similar colour to the female, but the transverse blotches on the wing-covers are much more conspicuous, forming well-defined spots. The smooth areas of the prothorax and the cream-coloured spots on the sides of the meso and meta-thorax are contained in larger or smaller blotches of purple-blue. Small spots of the latter colour are also distributed on the joints of the limbs. There are also two broad transverse blue bands on the upper and outer surfaces of the posterior femora. Expanse of wings, 4 inches; length of body, nearly 2 inches. Femora reaching to the tip of the abdomen.

Young.—The young of both sexes are yellow-green with various markings.

Variety.—There is a variety (or distinct species) which in the female at least presents the following characters: The prothorax has a longitudinal nuchal, and a broader inferior marginal cream-coloured band. Instead of being almost glabrous (a feature found in the above insect) this variety is markedly pubescent. Each side of the corselet, also, instead of being almost smooth, has a conspicuous anterior posterior ridge. The expanse of wings is $5\frac{7}{8}$ inches.

Habits.—When disturbed these insects, in the first instance, attempt to conceal themselves by clinging closely to branches, etc., in which position their dull colours serve to protect them from observation. They afterwards make prompt and prodigious leaps, although they do not at these times fly far unless supported by the wind. Both

* Orthoptères. Paris, 1839, p. 640.

adults and young may be found together at Brisbane all the summer through, from September onwards. They deposit their eggs in the ground in a cavity which they have previously made with their strong anal forceps. In this operation the four hard corneous portions of this organ are first held together so as to form a drill, which is then thrust into the ground, after which the component parts are forcibly opened outwards by means of strong muscles, and so the hole is formed. The eggs are not placed so far beneath the surface as in the case of the locust of the pastures, described in this Report, neither does the present insect occur in such swarms as does that pest.

Remedies.—Attempts may be made to induce this grasshopper to eat plants which are poisonous to it (*vid.* "Remedies" under *Pests Destructive to Pasture—Grasshoppers*, p. 220), but then the insects are large and conspicuous objects, and after a little practice may be caught in a net, or with the hands alone, without any great difficulty.

Rust (*Phytopus*, sp.).

This affection, when its presence is pronounced, gives rise to the designation "Black" or "Maori," as applied, in Australia, to the fruit of the orange. It is more commonly met with in New South Wales than in Queensland.*

Description.—The "Rust of the Orange" is the subject of a very exhaustive report by H. G. Hubbard, who describes this affection as it occurs in Florida in the following words:—"In appearance the rust varies from a light or dark-brown stain beneath the cuticle, to a rough incrustation resembling an exudation of resinous gum upon the surface. In the former case the golden colour of the ripe orange is more or less obscured, and in the latter entirely destroyed by the discolouration. When entirely coated with rust the surface becomes finely chapped and roughened, giving to the unripe fruit a likeness to russet apples . . . . A microscopic examination of the fruit-rind reveals no forms of fungus, but shows the oil cells to be more or less completely emptied of their contents, and the outer layers, the epithelial cells, clogged with brownish resin, or entirely broken up and divided by fissures which permit evaporation of the fluids from the underlying cells. The rind of rusted fruit, therefore, shrinks and toughens, and loses by evaporation or oxidation the greater part of its essential oil."†

Cause.—H. G. Hubbard detected in depressions on the surface of rusted oranges, groups of minute white filaments—the cast skins of insects, and on examination of oranges at a different time of year "the former occupants of the cast skins—elongate mites, of honey yellow colour too minute to be seen as individuals with the unassisted eye, but visible in the aggregate as a fine golden dust upon the surface of the fruit." He also found the mite on the leaves of trees of citrus in all ages, and concluded that in this situation they propagated all the year round. On the leaves they gave rise to the following pathological condition: minute pimples or elevations existing to such an extent as to cause the leaf to become finely corrugated, glossless, and to present a corroded, dusty appearance, and to assume a warped condition as in

* *Vid.* G. Bennett, M.D. "Introduction, &c., of the Orange in New South Wales," p. 17.

† Report of the Commissioner of Agriculture. Washington, 1881, pp. 361-2.

droughts. In fact, he was led to conclude that this mite, a species of *Phytopus*, was the cause of the rust. This acarus occurred, as Hubbard demonstrates, in such numbers that upon a portion of the surface of a leaf measuring a $\frac{1}{4}$ square inch 1,142 of its eggs were counted.

Effects on Fruit.—"If severely attacked by rust before it has completed its growth, the orange does not attain its full size; very rusty fruit is always small. Its quality is, however, improved rather than deteriorated. The toughened rind preserves it from injury and decay, prevents evaporation from within, and carries the ripening process to a higher point. They can be shipped without loss to greater distances than can bright fruit, keep longer, and are also superior in flavour." (P. 368.)

Remedies.—Any preparation used must be applied to the foliage of affected plants. Hubbard after careful observation and experiment found that the chief difficulty was in destroying the vitality of the eggs of the phytopus which offered considerable resistance. Ultimately he recommends as an effective remedy for the Rust mite the use of a solution of 1lb. of whale-oil soap to 5 gallons of water. This should be distributed over the foliage in the early spring prior to the commencement of new growth, and the application repeated two or three times.

NOTE.—*Scabby Lemons.*—It is quite common to see lemons, retailed in the Brisbane shops, presenting the following characters :—Their surfaces are very uneven and remarkably rough, and instead of being uniformly green or yellow, either these colours are combined and indistinctly varied by pale-brown, or the whole fruit is brown-coloured. In fact, they have a shrivelled-up appearance, a feature which is enhanced by their small size. More close examination reveals the presence of scab-like patches of a light-brownish white colour, often more or less fissured, and blotches, or specs of the same description. The material of these patches, blotches, and specs is of a fungus nature, and in the case of the two latter may cover scale insects. Wherever the surface is not involved in these patches it appears corrugated and generally as being one large ciccatrization. On two examples of such lemons, purchased at Brisbane in October, we have found specimens of the Red Scale, Glover's Scale, and the Red Spider—the latter in profusion. In the case of these it was not thought necessary to inquire further into the origin of the disease. In other instances it will be found to be due to the Ramularia Fungus, accompanied or not by a Phytopus mite.

FUNGUS DISEASES.

BLACK SPOT.

Several fungi—whose presence is associated with black specs, spots, or blotches—occur on the leaves and other organs of orange trees at Toowoomba. Except in such cases in which they discharge the green colour of the leaf, and they are also in profusion, it does not appear likely that they occasion much injury.

Amongst those collected at Toowoomba one was referred to the eminent specialist, M. C. Cooke (and for this reference we are indebted to Mr. F. M. Bailey). This authority designates it "Glœosporium citricolum, C. M.)*

* Messrs Cooke and Massey thus describe this fungus: "Maculis atrofuscis, parvulis, subdiscoideis, sæpe confluentibus; acervulis immersis; conidiis ovalibus, continuis, hyalinis, 8 x 6 micro-mil." *Grevillea*, September, 1887, p. 3.

Fungi, occasioning such black disfigurements as the above, and found in Italy on both the living as well as the dead leaves of citrus plants, have been figured (and described) by Saccardo, whose published writings should be consulted by those who wish to study the subject.*

Orange Leaf Scab (*Ramularia*, sp.).

The following appearances characterise the presence of this fungus disease. The surface of the leaf is usually coarsely corrugated, especially in the later stages of the disease, causing the margin to be waved. On young leaves still flaccid there are small, nearly circular, sharply defined, irregularly bordered, light brown scabs, having an average diameter of 2 mm. ($\frac{1}{12}$ inch). These are flat or shallowly depressed in the centre. The central area is darker in colour than the other portion of the fungus, and on examination with the lense will be found to be downy—the pubescence being due to the presence of threads of the fungus. This fungus occurs on either side of the leaf, and the portion of the leaf immediately opposite a scab presents the following appearances as the fungus grows :—At first there is a rusty yellow circular or elliptical spot, having a few low papillary elevations. This then becomes depressed in the centre, in which position appears a darker area with irregular border. The position of those scabs growing on the under surface is usually indicated above by an encircling halo of yellow shaded off into the general green of the leaf. As the leaf attains its full size these scabs, which do not increase in area with it, may have their surfaces ruptured. On older leaves these scabs become considerably elevated, forming conspicuous light brown irregular tuberosities. Upwards of fifty of these scabs may appear on a single leaf. They occupy all positions on it, and are often contiguous on the

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* *Vid.* "Fungi Italici Autographice Dilineati," Fasc. xxix-xxxii. Batavii, Aug., 1882. The following is a list which we have compiled of these fungi occasioning black spots on orange leaves :—

Black spots on Orange leaves in Italy, whose presence is not attended with other discolouration of leaves.

Meliola citri (Briosi et Passerini). Sacc. Pyrenomycetes.
This causes a disease named in Italy " Cinere."
Meliola Penzigi. Sac. Pyrenomycetes.
Antennaria elæophila. Penz. Pyrenomycetes.
Læstadia socia. Penz. Minute black spots. Pyrenomycetes.
Microthyrium citri. Penz. Minute black spots, remote. Pyrenomycetes.
Sphærella sicula. Penzig.
Phyllosticta Beltranii. Penzig. On mid-rib beneath. Sphærop.
Phyllosticta micrococcoides. Penzig. Younger leaves. Sphærop.
Phyllosticta platanoidis. Sacc. Fallen leaves. Sphærop.
Phoma Mantegazziana. Penz. Faded leaves. Sphærop.
Phoma rigida. Penzig. Fallen leaves. Sphærop.
Phoma scabella. Penz. Fallen leaves. Sphærop.
Septoria citri. Passerini. Faded leaves. Sphærop.
Septoria sicula. Penz.
Septoria Tibia. Penz. Younger leaves. Sphærop.
Ascochyta Hesperidearum. Penz. Fallen leaves. Sphærop.
Glyœosporium Hesperidearum. Catt. Faded leaves. Melan.
Cladosporium elegans. Penzig. Faded leaves. Hyphomycetes.
Cladosporium herbarum. Faded leaves. Hyphomycetes.
Beltrama rhombica. Penzig. Fallen leaves. Hyphomycetes.
Valutella fusaroides. Penzig. Hyphomycetes.
Epicoccum micropis. Corda. Fallen leaves. Hyphomycetes.
Epicoccum nigrum. Dead leaves. Hyphomycetes.

petiole, in other parts two or more may become confluent. Sometimes they are equally distributed on the two surfaces of the leaf; in other instances they occur exclusively on one. Their usual effect on the citrous tree is to cause it to shed its leaves—these having previously become of a yellow colour. Often, however, the leaves persist and do not appear in any way etiolated. Usually trees affected with the disease yield poor crops, and we have seen instances in which it was present and not a single orange was "set." Most frequently it seems to affect seedling trees. The lemon is perhaps especially subject to it. It is equally common in the Toowoomba district and in South Queensland. The following is the description of the fungus:—

Ramularia, sp.—Spots, well defined, light brown; central area, clouded with darker colour; general outline, circular, with waved margin; diameter, about 2 mm. Border, slightly raised, and in old specimens ultimately black. Central area, depressed, ultimately raised with the whole spot, which becomes uniformly brown, much above surface of the leaf. Fertile filaments, or threads (*hyphæ*), crowded (*cæspitose*), naked, free, erect, simple, sometimes continuous, but usually obscurely septate, even, or constricted here and there—for the most part straight, pale coloured, hyaline, containing granules and longer than the spores (*conidia*). Conidia borne on apices of the hyphæ singly, or sometimes two in line or succession; cylindrical obtuse, three or four times as long as broad, uniseptate, each division nucleated and containing granules. Spots occurring on both surfaces of the leaves and on petioles.*

The species of Ramularia belong to the family of fungi known as the Hyphomycetes. They are found growing upon the surfaces of living leaves, their mycelium (or vegetative organs) being extended into the intercellular spaces of the subjacent tissue.

Remedies.—We are unable to suggest any remedy. The employment of methods tending to secure the robust health of the tree generally, may help to keep it free from the presence of the disease.

Fumagine or Black Mildew.

The smutty appearance of orange trees is a very familiar feature in the Toowoomba and perhaps in every other district of Queensland. It may be best described in the graphic language of the French naturalist, J. B. Robineau-Desvoidy, which we translate. He remarks: —Olives, citrons, oranges, and a host of other trees cultivated in this climate (Nice) are the prey of an affection which the Italians name *morfeé*, for they have compared it to a particular skin disease. It is a black crust or scurf which covers the trunk, the branches, the leaves and the fruits of trees, sometimes throughout considerable areas. The growth of the plant affected is stopped or impaired, the trees become languid, fall away and are sterile. They present only objects of disgust and repulsion, and may endure for several years in this

* A species of this genus has been described under the name Ramularia citri, Penzig. (Fung. Agrum., No. 112). P. A. Saccardo has figured it, in Fungi Italici Autographice Dilineati, Patavii, 1882, Tab. 1195, from specimens found on fallen orange leaves. The characters presented by the Queensland species agree, generally only, with those delineated by him; but identification is uncertain in the absence of any verbal description of R. citri, or even of a representation of the characteristic spots, by which the presence of this pest is manifested.

sorry condition. At other times the malady suddenly leaves a locality for one more or less neighbouring, which it in turn ravages.*

The explanation of the injury occasioned by this Fumagine (the name by which, according to Robineau-Desvoidy, it is known in the north of France) is found in the following statement made by the Rev. M. J. Berkeley. He remarks: "It is impossible that light can have its proper effect through such a medium on the tissue of the leaves. It would be as rational to expect that plants would thrive under a brown bell-glass as that vegetation should not be impaired where the greater part of a plant is covered with a thick dark felt."† It acts also by checking transpiration from the surface of the leaves, and so the movement of the sap. This may be concluded from experiments mentioned in the *Report of the Department of Agriculture, Washington*, 1882, and first noticed in the "London Cottage Gardener." In these experiments two orange trees, weighing respectively 18 and 20 ounces, were allowed to vegetate without their leaves being cleaned from dust for a year; and two others, weighing respectively 19 and 20½ ounces, had their leaves sprayed with tepid water once a week; the first two increased in weight less than half an ounce each, while of the two latter one had increased two and the other nearly three ounces. Except the cleaning, the plants were similarly treated.—*Op. Cit.*, p. 333. If such may happen in the case of ordinary dust and its limited deposition, what would be the result if the Fumagine had been concerned?

Its Nature.—If the smutty matter be examined by aid of the microscope it will be observed that it is composed of more than one form of fungus. These fungi have been described as species of *Erysiphe*, *Antennaria*, *Fumago*, and *Capnodium*, and are represented on Plate 22 of W. M. Maskell's "Account of New Zealand Scale Insects," and by W. G. Farlow, in "Bulletin of the Bussey Institution," Part v. Harvard, 1876—under the name *Fumago salicina*. It is also obvious that this matter is quite superficial on the leaf, and may easily be peeled off—in fact, that the fungi must live on and at the expense of some substance which occurs on the leaves themselves. Now this substance is none other than honeydew. But whence is this honeydew derived?

M. J. B. Robineau-Desvoidy, on page 184 of his previously quoted article, remarks that the most rational interpretation of the presence of the Fumagine is that it is related to, or is a consequence of, the puncture of cocci or Scale Insects. It is well known that certain scale insects excrete this sweet material, and W. M. Maskell has figured, on the above-mentioned plate, the very special tubular exsertile apparatus by means of which such honeydew is discharged. When plants are infested by Lecanidæ (such as the Black Scales, and Ceroplastes (of the Brisbane Botanical Garden), small spots of the latter fluid may be noticed on any leaves which happen to be beneath those on which these scale insects occur. Moreover, as Robineau-Desvoidy remarks, one only meets with the Fumagine on trees already attacked by Kermes —*i.e.*, Scale; in fact, its occurrence is an almost certain indication of the presence of scale insects—at Toowoomba, generally of the Black Scale (Lecanium oleæ).

* "Memoire sur le gallinsectes de l'olivier, du citronnier, &c., dans la province de Nice et dans le Department du Var." *Compt Rend.*, 1852, p. 183.

† "Introduction to Cryptogamic Botany," by Rev. M. J. Berkeley, Lond., 1857, pp. 276-7.

Remedies.—The Fumagine may be removed by alkaline washes, such as ordinary ley—from wood ashes; but it is very obvious that the proper treatment, indicated by the facts mentioned, is one which commences with the scale insect itself, on the occurrence of which the presence of this affection depends. If bodies are used which only reach the Fumagine, they—by rendering the surface "clean"—but allow the scale insects, which cause it, to still further extend their depredations.

Foot Rot.

Vid. 2nd section, or Chapter I., of this Report under "Citraceous Plants," pg. 33. This malady will be further dealt with at some future time.

Shrub Dodder—(*Cassytha*, sp.).

This is a leafless twiner with wiry stems, small flowers on pedunculate spikes and almost spherical smooth fruit. It is a parasite with the habit of the true Dodder (Cuscuta). Starting life from a seed in the ground, the young plant early seeks the stem of some host plant up which it may arise and amongst whose branches it may twine, and having reached the latter position it fixes itself by means of small suckers developed on its stems. Henceforth, its connection with the ground being meanwhile severed, it proceeds to live at the expense of the sap of its supporter; but insomuch as its tissues contain chlorophyl, and are accordingly able to assimilate formative material, its parasiticism is limited to the withdrawal only of water and mineral substances from its host, and the injury which it occasions is restricted to this action, and—insomuch as it grows in dense masses—to the mechanical effect due to its twining habit. Happily the association of this pest with economic plants is of rare or unprecedented occurrence, these remarks having been suggested by a single instance afforded by a well-known local orangery. The particular species in this case appeared to be Cassytha filiformis, *Linn.*, which, according to the late Mr. Bentham, "is widely spread over tropical Asia, Africa, and America, chiefly in maritime districts."*

Snails.

Professor T. Kirk has pointed out that "the introduced mollusc (Helix aspera—imported from Great Britain) is a dangerous enemy in New Zealand to all kinds of citraceous plants, and is frequently found infesting the trees in large numbers." † Our experience in New Zealand has taught us, too, that it is also very destructive to other economic vegetation. This pest already occurs about Melbourne and Sydney, but we have yet to learn that it has established itself in any part of this colony. It is our duty, however, to point out the possibility of its being introduced any day, by its eggs being contained in the soil in which imported living plants are growing, on the arrival of the latter here. No complaints have been made of injuries inflicted, on orange or other fruit trees, by snails or slugs indigenous to Australia. There may however, be observed on orange trees in the vicinity of Brisbane, and feeding on the minute Algæ and Hepatics which grow in such situations, three little snails of different species. These are Achatinella

* Flora Australiensis, vol. v., p. 371.

† "Fruit Blights and Diseases of Fruit Trees." Reprint, p. 33.

(Frickella) Wakefieldi, Cox; Succinea eucalypti, Cox; and a minute and apparently undescribed species of Helix. Their existence, however, in such a station, though interesting to conchologists, is not of much importance to the orange-grower.

CHAPTER V.

Miscellaneous Fruits.

THE FIG.

Fig-leaf Galeruca (*Galeruca*, sp.).

This is a small brown beetle, thickly clothed with short fine pubescence, measuring from $\frac{5}{16}$ inch to $\frac{7}{16}$ inch in length, and having an oblong-shaped body and conspicuous rather long antennæ.

It was the only fig-tree pest we noticed at Toowoomba, and it is common also throughout the coastal districts of Southern Queensland. Both in the grub and during its adult condition it consumes the leaf of this tree, which it gnaws from the edge inwards until little but the stalk is left. The eggs are deposited in little batches upon the leaves, and the larvæ arising from them, when fully grown, fall from the trees and pupate within the soil. The Galeruca is gregarious in its habits. In the case of full grown fig-trees the damage inflicted is not so material as it is when young plants are attacked, and which not infrequently lose, from this cause, the whole of their vegetative organs. The following description may serve to identify the insect:—

The Beetle.—Body parallel-sided, closely punctured. General colour dull brown, with a round spot in the centre and one within each lateral angle of the prothorax, a round spot in the centre of the front, and the scutellum, black. Antennæ limbs and greater part of centre of abdomen piceous, a faint intra-marginal ill-defined dark stripe on the elytra. The whole surface clothed with dense short glistening pubescence, rather sparing on the prothorax. Head rather narrower than prothorax, and free from it. Mandibles each with three teeth at their point of union. Labrum rounded entire. A longitudinal impression runs down the centre of the front, and is continued on the clypeus; the latter with a stout ridge down the centre, which unites with one which passes to either side in front of the antennary fossæ. Antennæ with third joint rather longer than the fourth. Eyes large, prominent. Prothorax transverse, fore border shallowly excavated, hind border arcuated on each side of a similarly shallow excavation, lateral borders deeply flexuous, fore-angles angular, hind-angles obtuse, a wide irregular depression crossing the central part of the surface; scutellum large, triangular, obtuse. Elytra sub-parallel, very slightly narrowed behind humeral angles, finely bordered internally, a stronger slightly revolute external border, confusedly punctured. Epipleuræ narrow, sub-concave in front, continued to posterior border. Presternum forming a narrow elevated keel between the anterior coxæ. Anterior cotyloid cavities shallowly open behind. Metasternum not projected between middle coxæ, with large parapleuræ. Tibiæ unarmed. Tarsi with first joint less than two succeeding, third joint with pulvillus of yellow hairs. Claws bifid, inner division the smaller. Length, $\frac{5}{16}$in.–$\frac{7}{16}$in.

Larva.—A narrow cylindrical grub tapering towards each extremity, with dark-coloured head, and three pair of well developed thoracic legs. Upper surface granular; each segment with two transverse rows of large blunt papillæ, which bear three or more glandular setæ a-piece. The two centre papillæ of each transverse row unite, and so form a centro-dorsal longitudinal band; the large lateral ones, occurring at the same level on each segment, give a serrated appearance to the grub. The last segment is flattened and widened towards its posterior border, where it is truncated and emarginate.

Eggs.—The eggs are fusiform, with one end gradually tapered and apiculate, 1·75 mm. in length. They are placed side by side with the pointed ends outwards, in batches of about a hundred, on the under surface of the fig-leaf.

Remedies.—1. The beetles, or their larvæ, may be stayed in their ravages by poisoning the leaves upon which they are feeding. For this purpose the method recommended in dealing with the potato beetle may be followed. (*Vide* "Potato Beetle," p. 183.) 2. By "working" the ground at the foot of the trees the pupæ may be exposed, and so be fed on by poultry; fewer beetles would thus be left for doing damage during a subsequent season than would otherwise be the case.

Red-banded Galeruca (*Luperodes*, sp.).

(*See* under "Maize," p. 192.)

MULBERRY.

Leaf-eating Caterpillar (*Fam. Noctuæ*).

On two occasions during the Toowoomba inspections the leaves of mulberry trees were observed to be extensively eaten by the caterpillars of a noctuid moth. This pest may be recognised by the following characters:—

The Caterpillar.—Body cylindrical; the eleventh segment with a conspicuous transverse hump, beyond which it is inclined; anal prolegs stout. General ground colour yellowish white, finely hackled with irregular black lines, most conspicuous on the sides; also mottled with greenish grey. The back is conspicuous as being of a lighter colour than are the sides of the body. There is a lateral orange-coloured fascia from the fourth to the sixth body-segment, and a whitish infero-lateral patch on the tenth and eleventh. Spiracles brown, edged with black and white. Body sprinkled with white, black-edged setigerous spots. The spots, twelve in number, have on the middle segments of the body the following disposition: There is one on each side of the middle line, one below this at the union of the dark and light portions of the side of the body, one immediately above the spiracle, one just behind it, and another below it. The thoracic legs are shining reddish yellow; the head is of a somewhat lighter colour, with the frontal area clouded with brown. Length of body, 1½ inch.

Fruit Weevil (*Brachypeplus*, sp.).

This insect is very destructive to the fruit of the mulberry at Toowoomba. It finds its way amongst the little berries constituting the fruit, as soon as this has commenced to ripen, and then feeds upon them. (*Vide* "Peach," p. 82).

Red Scale (*Aspidiotus coccineus*).

Mulberry trees about Brisbane may be noticed in many places to be gradually dying, branch by branch, from the attacks of the Red Scale. This coccus forms a complete investment of the boughs, and encroaches upon the young branchlets as they arise. (For a description of and mode of dealing with this pest the reader is referred to the section of the Report relating to the "Orange," pp. 129-31).

Black Scale (*Lecanium hesperidum*).

Observed, only at Brisbane, upon the leaves and branches of the mulberry. (*Vid.* "Orange," p. 122.) In one instance it was noticed that each scale was surrounded by a white halo, of fungoid growth, and that the insects had succumbed to the attacks of this vegetable parasite. The precise nature of this fungus as yet awaits determination.

PASSION FRUIT.

Leaf-eating Caterpillar (*Acræa melicerte*).

It is well known that certain varieties of the passion vine have their foliage fed upon by the caterpillars of the butterfly Acræa andromacha, *Fabr.*, popularly known about Brisbane as the "Greasy." These caterpillars are easily recognised from the fact that they support a number of bristling spines. The damage, however, which they occasion is comparatively insignificant. Moreover we have never met with them on the fruiting varieties.

Fruit Borer (*Heliothis peltigera*).

Symptoms.—We have observed at Brisbane that when the passion fruit is still green and soft its growth may be suddenly checked, whereupon it will fall to the ground. The fallen fruit exhibits a hole usually situated near the insertion of the stem, in which spot it is concealed in great measure by the dried remains of the flower. This orifice leads into the cavity of the passion fruit which, in the place of the white seeds, is now filled with the translucent dirty-white excreta of a caterpillar. Usually the latter may be found engaged in still gnawing at the fleshy portion of the rind, having already consumed the seeds. It is none other than the troublesome pest which injures the corn plant, bores into tomatoes, into the pods of peas, and the buds of roses, in Queensland; and damages the poppy and cotton crops, in America and India respectively—*i.e.*, the caterpillar of a form of the cosmopolitan moth *Heliothis armiger*. (*Vide* under "Maize," p. 189.)

Black Scale (*Lecanium Oleæ*).

In the garden of Mr. Gregory, of Drayton, we met with a passion fruit plant which had succumbed to the attacks of the Black Scale. This was still crowded upon its leaves and branches. No other instance of the occurrence of the pest with this association was met with. (*Vide* "Orange," p. 124.)

STRAWBERRY GUAVA (*Pisidium*).

Case Moth (*Entometa ignobilis*, Walker).

The strawberry guava (Pisidium) is subject, at Toowoomba, to the attacks of the caterpillars of the above Case Moth.

Habits.—These pests may be recognised by their curious habit of constructing cases from the small twigs of the trees, the leaves of which they have previously in part consumed. These twigs or branchlets are fastened side by side in a longitudinal direction upon the outer surface of the cases. The caterpillar, whilst still within the case passes into the chrysalis condition. The adult male insect is a curious fly-like moth, with transparent wings, plumed antennæ or feelers, and hairy elevated body. The adult female insect never attains to the winged state, and presents a very different appearance from the male. She does not ever forsake the protection which the case affords. In the spring of the year, and whilst still within the case, the female gives birth to numerous minute larvæ, which, letting themselves down from their birthplace by means of fine threads, alight upon the leaves of their host plant, and no sooner do they commence to feed than they start building cases for themselves—at first of tiny fragments of leaf and afterwards of branchlets.

The depredations that these curious insects are responsible for, under some circumstances, may be concluded from the fact that twelve individual case-moth caterpillars were found, without very close observation, upon a guava tree, still but a few feet high; and that each of their cases contained on an average seventeen guava twigs, measuring in length from two inches downwards.

Remedies.—Hand-picking appears to present an easy method of ridding trees of these pests. It is satisfactory, moreover, to be able to recognise the fact that the caterpillars are extensively preyed upon by hymenopterous parasites.

LOQUAT.

Fruit Fly (*Tephritis*, sp.).

There are two kinds of Loquats grown at Toowoomba. One, the fruit of which ripens in September, and is as large as a pigeon's egg; and another, which bears fruit of a much smaller size, which is not ripe until the following month. It is the latter variety alone which, when fully ripe, is liable to be attacked by the Tephritis (*vid.* "Fruit Fly—Peach," pp. 54-75).

JAPANESE DATE PLUM or PERSIMMON.

Fruit Fungus.

There are two kinds of Persimmon grown at Toowoomba. No complaint as to either being subject to any disease came under notice. It was, however, observed that the still green fruit of one variety was covered on one side with numerous small black spots. These, on examination, proved to be indications of the presence of a fungus allied to *Glœosporium* (*vid.* "Apple," p. 50), the spores of which were 3-nucleated, and measured $\frac{1}{5416} - \frac{1}{3611} \times \frac{1}{10833}$ inches.*

WALNUT.

Fruit Fly.

A diseased condition of the Walnut is referred to in dealing with the Fruit Fly of the Peach. This is occasioned by the maggot of a fly

* The Report is indebted for these measurements to T. L. Bancroft, M.B., &c.

which deposits its eggs in the acrid pericarp of the fruit. The fly in question has not been reared, but having instituted a comparison of its larva with that of the ordinary Fruit Fly, we are enabled to affirm that the adult insect must be very different from the latter (*vid.* "Walnut," p. 36).

CHAPTER VI.

THE VINE.

Insects—Lepidoptera.

Sphinx-moth Caterpillars (Fam. *Sphingidæ*).

There are three caterpillars—the early stages of as many different moths—of the family Sphingidæ, which devour the foliage of the vine. The adult insects are rapid flyers and choose the evening for their hawk-like movements. They feed amongst flowers, the honey of which they extract with their ordinarily spirally curled up tongues.

(1.) The first is *Chærocampa erotus*, and the following is the description of its different phases :—

Egg.—Not observed.

Caterpillar.—Tapering towards the head from the fourth segment, remainder of body of nearly uniform breadth; smooth, perfectly naked. The eleventh body segment with a stout curved black-tipped horn. Three pair of thoracic, or true legs; four pair of abdominal, and one pair of caudal pro-legs. General colour brownish-yellow, with head and following segment lighter coloured; on each side of caterpillar a series of ocellated spots—white broadly margined with grass-green. These spots, which are of different size, occur on the third to tenth body segments, inclusively. From the root of the dorsal horn there diverge two black bands which are continued on either side of the body, traversing the lateral ocellated spots as far as the middle of the sixth body segment. The surface of the body between these bands—*i.e.*, the back of the segments, has a redder tinge than the remaining portions, and is freckled with small black specs which frequently coalesce. From immediately behind each lateral spot arises an oblique anteriorly directed descending band; these bands are continued on to the outer surface of the pro-legs—on the segments on which the latter occur; those bands arising from the fourth to eighth spots are bounded anteriorily by regular triangular patches of black, freckled with reddish-brown, which patches occupy the space intervening between the bands and the spiracles; those on the fourth and fifth segments pass beneath the body. The second body segment is traversed by three faint longitudinal dorsal bands and two lateral, broader and more pronounced ones. The supra-anal shield and abdominal prolegs are coffee-brown, the former margined with white. The thoracic legs, the labrum, and mouth organs are greenish-horn colour. Clypeus very pale coloured. Mandibles tipped with black. Length, $2\frac{3}{4}$ to 3 inches.

Chrysalis.—This is formed in a leafy cocoon at or near the ground.

Adult.—The adult insect is a large red-brown moth, having a stout fusiform body—*i.e.*, tapering towards each extremity. The outer surface of the antennæ, a line over the eye and continued on to the base of the wings, base of abdomen beneath on each side, outer surface of tibiæ, the terminal joints of legs, the sides of the sheath of the proboscis and throat white. The forewings are rich dark-red brown, with a lighter reflection, and are traversed near the base with two undulating brown lines, and two broad darker brown bands between these and the apex of the wing. The hind wings are orange yellow, bordered with dark-brown and edged with white. The under-surface both of the wings and body are of a decided red brown,

the wings being covered with fine lines and spots of black. The eyes are rich chocolate brown, and very conspicuous. The tibial spurs of the hind and middle pair of limbs are very stout. The antennæ directed forward, are stout, and end in sharp points. Length of body $1\frac{1}{2}$in.; expanse of wings, 3 to $3\frac{1}{2}$in.*

The larva has, like many others, the faculty of elongating and contracting the three anterior narrowed segments of the body, a habit which has gained for the moths, whose caterpillars are thus endowed, the name of elephant sphinxes. The caterpillars of several species of moths belonging to the family Sphingidæ are known to feed exclusively on the vine. This is specially the case with those of the genus *Chœrocampa*†—the silver-striped hawk moth, *C. celerio*, which is stated to be distributed throughout the world, being another instance of the occurrence of this habit in the genus. Both it and *C. erotus* are tolerably plentiful in the neighbourhood of Brisbane. The latter ranges as far north as the Solomon Islands.

(2) *Chœrocampa*, sp.—A caterpillar having the same habits and also the same general shape as has the last mentioned, and no doubt belonging to the same genus—*Chœrocampa*—has been observed at Brisbane doing much damage to young vines. The following description may serve to distinguish it:—

Caterpillar.—General ground colour, cream, most conspicuous and becoming brownish-yellow on the upper part of fourth segment, almost obscured by brown on second and third segments; also on those posterior to the fourth a well-defined black line along the centre of the back, and two fainter lateral ones occupying second, third, and fourth segments; fourth segment with a large ocellated spot, the centre of which is black bordered posteriorly by purple and white, on each side; the lateral spots of succeeding segments yellow. From the root of the dorsal horn there diverge two well-defined white-coloured, irregularly spotted with dark brown, bands which are continued on either side of the body; the surface of the body between these bands —*i.e.*, the back of the segments, is dark-brown faintly speckled with numerous yellowish spots. Seven large triangular black blotches, one on each segment, from the fifth to the eleventh inclusive; outer surface of abdominal prolegs black; under surface of second, third, and fourth segments black, abruptly contrasting with light colour of remaining segments beneath. Spiracles blackish with white spots above and below. Head greenish horn-coloured, peppered with light brown.

(3) A large green, horned, caterpillar having lateral stripes, and much larger than either (1) or (2) was observed at Toowoomba, where it occurred solitarily on the vines. We have also noticed it at Brisbane.

Remedies.—No special remedy seems demanded to meet the attacks of these sphinx caterpillars, as, during a great part of their life, they are large and conspicuous, and may easily be hand-picked and destroyed; or they may be—more readily—fatally injured, by snipping them with scissors whilst they are occupied in feeding.

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* *Chœrocampa erotus* is figured in Cramer's "Papillons Exotiques," 1779, ii., p. 12, pl. 104, fig. b.

† Nine species of this genus occur in Australia.

CATERPILLAR (*Fam. Noctuidæ*).

This caterpillar is very destructive to the vine wherever it occurs. It devours the young shoots and entire foliage, with the exception of the midribs and petioles of the leaves. Mr. G. Searle, of Rosehill Gardens, Toowoomba, stated that he found as many as seventy-five on a single vine. The following is a description of the insect :—

Caterpillar.—Body cylindrical, with the twelfth segment transversely humped, velvety, smooth, unclothed, but for the occurrence of six or eight stiff erect hairs which are present on each segment, those on that one succeeding the head being the most conspicuous. General colour above blackish-brown, with a lighter shade along the middle third of the upper surface, beneath pale. The dark colour above is caused by the presence of irregular fine waved longitudinal streaks on a light ground, these streaks sometimes coalescing on the sides. Along the centre of the back, fine streaks of the same colour extend continuously from segment to segment; these enclose a stripe of the general light body colour. Each segment has also white setigerous spots. Those on the first body segment are irregularly disposed, those on the second and third form irregular transverse series of ten each, those on each succeeding segment, except on the terminal one where they are indistinct, are eight in number, four being situated on each side of the middle line, of which one is dorsal, one supero-lateral, and two infero-lateral; the latter three are situated posterior to the spiracle of the segment, the supero-lateral one being further behind than the other two. A white-coloured fascia extends from the fourth to the sixth segment inclusively on each side of the body just below the spiracles. The peculiar streaked marking of the body extends on to the outer surfaces of the ventral prolegs. Mandibles black-tipped, with three strong blunt teeth, labrum emarginate, pre-labrum strongly longitudinally grooved, clypeus transversely striated. Head horn-colour, clouded in front with dark brown, a spot of the same colour occupying the centre of the clypeus. Thoracic, or true legs, horn-colour, terminating in black claws. Length upwards of 1 inch.

These caterpillars during the day generally conceal themselves beneath the surfaces of the leaves on which they are feeding, and may easily be detached from their hidingplace by shaking the vine. When fully matured they bury themselves in the loose soil beneath the vine, and having in this position spun for themselves a light cocoon to the outer surface of which particles of earth are attached, afterwards pass into the chrysalis state. From the chrysalis they emerge as night-flying moths.*

Remedies.—Shaking the vines and then treading the caterpillars, which have fallen, under foot, seems to be a plan which can be readily adopted with a view to lessen the injury which they occasion. In dealing also with these caterpillars, and others of related habits, we have little doubt but that much good will result from the use of poisoned traps. The traps are composed of cabbage-leaves, or small bundles of whatever green stuff the caterpillars are partial to. The poison may be Paris Green or London Purple. The following statement relates to such a procedure :—

"After the land is prepared for cabbages, or any other crop requiring protection, I place cabbage or turnip leaves, in rows 15 or 20 feet apart all over the field, and about the same distance apart in the rows. The leaves are first dipped in a well-stirred mixture of a tablespoonful of Paris green to the bucket of water; or they may be first moistened, then dusted with a mixture of one part of Paris green to twenty of flour, and placed carefully

* Owing to an accident the later stages of this insect could not be observed.

with the dusted surface next to the ground. Two such applications, particularly in cloudy weather, at intervals of three or four days, will suffice to allow the cut worms (caterpillars of noctuid moths—Agrotis spp.) to make away with themselves, which they generally do, with perfect success. This plan, first recommended by Professor Riley, is the best I have found. Whoever adopts it will rid himself of the pest at least cost and trouble, and will not be compelled to replant constantly or to sow his seed thickly."*

THE THORN BEARING CATERPILLAR (*Thalassodes pieroides*, Walker).

There can be little doubt but that this strangely formed and voracious insect which is so commonly met with in the gardens about Brisbane—where it attacks not only the grape vine and the rose, but the peach, plum, and guava also—will, too, be found occurring at Toowoomba.

The pest in question is the caterpillar of a member of the family of moths named Geometridæ, and is of a brownish colour with plano-convex dorsal surface and sides appearing coarsely serrate by being drawn out into conspicuous thorn-like expansions. When molested it bends its body into various positions and looks even more strange than before. Having grown to over an inch in length, it assumes the chrysalis condition and afterwards develops into a very interesting moth. This when settled has its wings expanded horizontally to a breadth of nearly eighteen lines and placed close to the object which is supporting it. These wings are semi-transparent, light sea-green in colour, of the most delicate texture, and finely scalloped at the edges. In one sex, the male, they are banded, mottled, and dusted with pure white; in the other, rusty-brown takes the place of the latter colour.

The following technical descriptions will aid in distinguishing the insect:—

The Caterpillar.—Brownish coloured and finely granulated, a dark spot above on each side of the first body segment, the central dorsal area of the third and fourth segments with a mesial and two lateral continuous fuliginous stripes, that of fifth suffused with the same colour. First body segment with a row of four erect blunt spines on the front and two on the hind border; six small similar spines on hind upper surface of second segment; two on the front and two on the hinder border of segments four to seven; on third, eighth, and ninth segment four spines on the hind border but none on the fore. The segments from the second to the eighth inclusive have the sides drawn out and expanded, so that the spiracles face upwards. These expansions diminish outwardly and gradually increase in size and lateral extent from the second to the fourth; those of the fifth, sixth, seventh, and eighth segments sub-equal. The expansions of the second and third body segments are toothed, that of the fourth terminates in a single thorn, whilst those of fifth to eighth segments terminate in twin thorns. The ninth and tenth body segments are normally cylindrical; the eleventh has two outwardly and backwardly directed hooks above; the twelfth segment terminates obtusely in a keeled border. Anal prolegs and one pair of abdominal prolegs present. Thoracic legs well developed. Length about 1 inch.

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* Dr. Oember, in reference to a Cabbage Caterpillar, in a letter to the United States Entomologist (*vid.* Rep. Commissioner of Agriculture, U.S.A., 1884, pp. 299-300).

The Chrysalis.—Light brown, with a few dark-coloured spots between the rings of the segments, finely granulated, gradually tapering towards the hind extremity on which are situated eight little hooked bristles. Length, $\frac{13}{20}$ inch; breadth, $\frac{3}{20}$ inch.

The Moth—Male.—Wings pale green, white beneath, marginal band of both wings white freckled with green, the freckles denser externally and internally forming a continuous waved line; inner border of band crenated by linear extensions of the cellulo-discal green area. A white band occupying the whole inner border of the hind wings extends right through the cell of the fore wings to their costal border. The veins traversing wings are barred with white, abdomen green above copiously covered with white, wholly white beneath. White scales interspersed with the green upon the head and thorax.

Female.—Sea green, body reddish, black and white speckled, white beneath. Head green in front. Palpi porrect, slightly angular, extending far beyond the head; third joint as long as the second. Antennæ with blackish rings. Fore border and tegulæ of the thorax green. Abdomen with two rows of elongated black marks. Hind tibiæ with four moderate long spurs; fore tibæ and fore tarsi black, with white bands. Wings ample, semihyaline, with a very broad band along the exterior border, undulating on the inner side, and of the same hue as the body; marginal points black, most distinct on the under side, where there is a black submarginal band; exterior border dentate. Fore wings acute; costa and exterior border convex, the former whitish-brown speckled, as is also the base of the wing and the adjoining part of the interior border; a green sub-apical spot. Hind wings extending beyond the abdomen. Length of body 8 lines, of the wings 18 lines.—(*F. Walker.*—Catalogue of Lepidop. Hetero-cera, part xxii. Geometrites, p. 581; *s. v.* Comibæna pieroides.)

Habits.—Restricting our attention to the injury occasioned to the grape vine, we observe that the Thorn-bearing Caterpillar is especially noticeable for its attacks upon young shoots and the bunches of fruit. In the case of the latter it consumes the cuticle of the peduncle and pedicels which support the bunch and the individual berries, and if the grapes are so far developed as to be contiguous, the caterpillar finds its way into the centre of the bunch and there carries on the same destructive work. The berries having their supply of nutriment in great measure cut off soon wither and die. When the caterpillar is fully grown it spins a very loose and delicate cocoon amongst the leaves, or occasionally in a recess in the bark of the vine plant, and within this cocoon changes into the chrysalis condition. The egg in the first instance is deposited in the food plant of the caterpillar. The moths are not uncommon throughout the summer months. We have procured examples of them, at Brisbane, from late in September until June. Sometimes this pest is a source of considerable damage to the grape crop.

Remedies.—It is not easy to suggest any. We have to deal with a caterpillar which feeds indifferently on a number of plants, and which, from its habit of mimicking the appearance of fragments of dead leaf, is difficult to detect.

LEAF-EATING TORTRIX (Fam. *Tortricina*, *Endemis betrana*, Schiff.).

Mr. E. Meyrick has observed that the caterpillars of this tiny moth spin together the shoots of grape-vines, and then feed upon the

young leaves and other organs. He has met with the moth at Rosewood, New South Wales, in March, May, August, and September.*

This pest may be expected to occur also in Queensland, but is not yet an object of complaint.

Insects.—Coleoptera.

Grape-eating Beetle No. 1 (*Rhyparida* (*Pyropida*) sp.)

At the season of the year when the berries are scarcely as large as peppercorns, the grape-vine at Brisbane is subject to the presence of this pest, which no doubt makes its influence felt at Toowoomba also. We have, too, observed it at Brisbane on the vine, during other stages in the growth of the latter.

Nature of Injury.—The leaves are gnawed, usually at the edges; but what is worse the young grapes are treated similarly, being bitten into nearly to the centre. The attack is generally more marked towards the pedicel, and often occurs on two sides of the berry; sometimes the pedicels themselves are gnawed as well. Being thus injured all subsequent growth of whatever portion of the berry remains is arrested; almost every berry on a bunch of grapes is dealt with in this manner.

Cause.—This injury is due to the attacks of a small beetle, belonging to the family Eumolpidæ, which feeds upon these portions of the grape-vine. This it does in its adult state. This beetle is oval-oblong in form and measures from 2 to 3 lines in length, according to sex. It is smooth and glossy, of a pale yellow-brown colour. The head is inclined downwards, the eyes are large and black, and the antennæ are slender and nearly half as long as the body. The head is immersed in the succeeding segment or thorax nearly to the eyes. The thorax is almost twice as broad as long, with nearly regularly arched sides; it is narrower across than the wing-covers. These are ornamented with thirteen linear series of small punctures.

Habits.—The beetle is somewhat gregarious in its habits, there being generally several about a vine at the same time. When approached the Rhyparida in an instant tucks its legs under, places its antennæ along and below its body and drops, quickly to take wing again, and sometimes even before it has reached the ground. It thus eludes capture with facility.

From what is known of the habits of its associates, we may infer that the eggs are laid on the ground at the foot of the vine, and that the larvæ feed too in this position.

Remedies.—The method of dealing with this pest, until we discover its precise life history, seems to be that of poisoning the foliage of the vine. This may be best accomplished by spraying an infusion of Pyrethrum over it, or dusting it over with a mixture of Paris Green and flour (*vid.* "Potato Beetle," p. 183).

The genus of plant-eating-beetles to which this insect belongs is represented in Australia by numerous species, seventeen of which are described. It also occurs in North America and the East Indies, but especially throughout the Indo-Malayan and Austro-Malayan

* Descriptions of Australian Micro-Lepidoptera, *Proc. Lin. Soc. N.S. Wales* vol. vi., p. 649.

region. The habits of none of these appear to have been recorded, much less has a grape-vine injuring propensity been attributed to any member of the genus. There is, however, a related European insect, associated with Rhyparida in the family Eumolpidæ, which has very similar habits. This is the *Bromius vitis* of continental vignerons. No doubt the methods which have been found useful in contending with this pest of the vine would be equally serviceable in dealing with its Australian relative.

The complete literature concerning the Australian members of the genus Rhyparida not being available for guidance in determining the species to which the present grape-injuring insect should be assigned, it becomes necessary to mention the following salient features which it presents :—

Rhyparida (Pyropida), sp.—Smooth, glossy, yellowish-brown above; head, antennæ, and under surface, reddish-brown; eyes and tip of mandibles black. Head minutely punctured, lower portion of front impressed and a shallow longitudinal groove running upwards from the apex of the epistome. Epistome plane rather coarsely uniformly punctured, distinctly separated from the front by deep apical sutures, rather broader than long;.apical angle obtuse; anterior border deeply concavely emarginate, angles of emargination blunt and apparently two-toothed, eyes strongly emarginate at their inner sides. Antennæ slender, of half the length of the body, second joint almost half smaller than third, reddish-brown. Thorax nearly twice as broad as long, the sides regularly rounded, scarcely narrowed anteriorly, all the angles tuberculate, hind border especially convex opposite the scutellum, surface covered uniformly with small punctures, as on head. Scutellum smooth, as broad at base as long. Elytra rather convex, obsoletely depressed below the base, nearly parallel-sided; striæ uninterrupted, regularly punctured, the punctations becoming finer towards the apex, surface smooth between the striæ. Femora unarmed. Tibiæ of middle and hind legs with well marked excavations. Length 2 to 3 lines.

The insect admits of much variation in colour: (1) Two specimens collected at the same time and place are piceous, with reddish-brown head, yellow-brown labrum and reddish antennæ and tarsi. (2) A single specimen is fulvous-brown, with posterior half of elytra piceous, and thorax, except anterior border, of the same colour. (3) Another is wholly yellowish-brown above, but with under surface, except hind borders of abdominal segments and middle third of femora, piceous-brown.

Grape-eating Beetle No. 2 (*Scelodonta*, sp.).

This is a small glossy dark bronzy-brown beetle, having the divisions of the body well marked. It measures from $\frac{1}{8}$ to a little over $\frac{1}{6}$ inch. in length. When in repose it has the head bent down and the antennæ directed backwards under the body.

Like the preceding beetle it is a member of the tribe Eumolpideæ, but belongs to a different section of it than does the former. In habits the two insects are closely comparable. The injury which they inflict upon the vine is of identical nature.

The present pest has not been met with at Toowoomba, but it is not uncommon in the neighbourhood of Brisbane.

The following are its more salient characters :—

Scelodonta, sp.—Colour very dark bronzy-brown or almost black ; the whole surface closely punctured and covered by a sparse depressed pubescence consisting of short white hairs. The head is immersed in the succeding segment or prothorax nearly to the eyes ; the front has a longitudinal groove down its centre, ending at the epistome (clypeus); a strong groove arising from the latter bounds each eye internally and above, at a short distance from the orbit; the eyes are sub-rotund, large and prominent; the epistome is conspicuously emarginate, the labrum slightly so ; the mandibles are bidentate at their extremities. The antennæ are less than half the length of the body ; they are inserted widely apart on the anterior lateral borders of the eyes, but arise quite free from the orbits ; they are 11-jointed ; the 1st joint is very short, the 2nd joint is stout, about half the length of the 1st ; the 3rd to the 10th gradually increasing in breadth but diminishing in length ; the 8th to the 10th are subequal in length ; the 11th is oblong and about equal to the 3rd joint. The prothorax is much narrower than the elytra, subcylindrical, swollen and rounded at the sides ; its lateral borders are hidden from above. The elytra are obovate, with ribs which are conspicuous at the base, sides and apex, but elsewhere obsolete. The humeral angles are prominent, the punctures are arranged in about twenty ill-defined rows on each elytron. The scutellum is pentagonal. The femora are swollen in their middle portions and have each a short stout blunt spur at the centres of their undersurfaces. The tibiæ are channelled, and the four posterior have also little hollows externally towards their ends. The tarsi are 4-jointed ; the first three joints are broad and subequal, the third being also deeply divided. The claws are bifid with the inner divisions the smaller. Length, $\frac{1}{8}$ to $\frac{1}{6}$ inch.

Remedies.—See under " Grape-eating Beetle No. 1," p. 157.

Wood-borer (*Orthorhinus*, sp.).

The pest in this instance is the larva of the beetle which is noticed as being associated, in Brisbane, with the destruction of the Peach-tree. (*Vid.* " Peachwood-borer," p. 79). This large weevil may be commonly met on the vines growing in the southern parts of the colony.

The Hon. W. Macleay, in a paper entitled " Observations on an insect injurious to the Vine," has detailed the damage done to vines in New South Wales by the larvæ of a closely allied beetle—Orthorhinus Klugii, *Schönherr.*—*Cf*, Proc. Lin. Soc., N.S.W., 1883, vol. vii., p. 345.

Fruit Weevil (*Brachypeplus*, sp.).

This insect appears to be identical with the weevil of the peach and other fruits. (*Vid.* under " Peach,"-" Fruit Weevil," p. 82). If the grapes are left hanging on the vines when they are already ripe, it is observed—both at Toowoomba and Brisbane—that the individual berries are liable to be injured by these insects ; which are associated, in their work of destruction, with the ordinary weevil of maize and other grain—*Sitophila oryzæ*, or an allied beetle.

Brown Grasshopper (*Acridium maculosum*).

This insect was observed in some vineyards of Toowoomba to be very destructive to the foliage of the vine. (*Vid.* " Orange," p. 141.)

Green Locust (*Phanoptera valida*).

The same remarks may be made concerning this insect. Not only does it feed upon the leaves but it also gnaws the green berry, as previously described. (*Vid.* "Orange," pp. 138-40.)

ACARINA.

Bryobia Mite.

This Acarus has been detected upon the vine both at Toowoomba and at Brisbane. Frequently it is associated with the presence of the fungus—Helminthosporium viticolum (*Sacc.*)—and is possibly attracted by the altered condition in the sap of the leaf which this fungus evidently occasions. Some idea of the nature of the injury for which it is responsible may be learnt on consideration of the influence of the presence of what appears to be an identical insect upon the fruitfulness of the Almond. (*Vid.* "Peach," pp. 92-94.)

Red Spider (*Tetranychus*).

This Acarus is of common occurrence on the leaves of grape vines growing in the neighbourhood of Brisbane. (*Vid.* "Peach," pp. 94-96.)

Brown Mite (Fam. *Oribatidæ;* Gen. *Leiosoma* [?]).

Specimens of a mite belonging to the family Oribatidæ were brought by Mr. F. F. A. Skuse, in April, 1877, from Durundur, South Queensland, as examples of Acari occurring upon the vine there. They may be distinguished by their smooth appearance, their dark-brown colour, the abdomen contracted before its termination and so ending in a blunt projection, their swollen femora, their three-clawed tarsi, their chelate toothed mandibles, and the toothed armature of their mouths.

There is no evidence of the nature of the direct injury which these Acari inflict upon the vine, but that they are fully competent to do much damage to the foliage and other parts is very certain. The particular examples examined were, however, interesting as showing a manner in which the fungus diseases of the vine may be communicated from one plant to another. One specimen of Leiosoma being crushed for the purpose of investigating its anatomical details, there were met with, amongst the fragments of the Acarus itself, several spores of the grape-vine fungus—Helminthosporium viticolum (*Sacc.*). These appeared to have been derived from the interior of the insect; at any rate, they had been adherent to its outer surface.

FUNGUS DISEASES.

The Oidium or Powdery Mildew.

The Oidium or Powdery Mildew, which occurs to a very large extent on vines at Toowoomba, is already too well known to need description, and those who would seek information on the subject cannot do better than consult Lawson Scribner's "Fungus Diseases of the Grape Vine," pp. 18-28, or the article entitled "Vine Mildew," which, written by Worthington G. Smith, is contained in the *Gardener's Chronicle*, May 15, 1886, pp. 619-22.

From statements recently published by Dr. M. C. Cooke it would appear that our Oidium differs from that of America or Europe, and we shall dwell on this opinion since it may throw important light on the source of the disease which is found here.

According to W. G. Smith "the fungus (*i.e.*, Oidium) was first seen in Queensland, Australia, in 1866 and 1867, and in Victoria and South Australia in 1869 to 1875." From an article on "The Vine Disease, Oidium Tuckeri," by A. R. Wallis, we learn that the vine mildew "first appeared in the gardens around Melbourne towards the close of the season 1870-1." . . . . "the first notice of it being made by Mr. John Smith, of Riddell's Creek, in a letter dated 11th December, and published in the *Australasian* of the 16th December, 1871."*

As there are several other fungi almost identical with the Oidium of the Vine which send up nearly similar pycnidia (*i.e.*, the form of fructification which contains the stylospores) and which afterwards perfect themselves as fungi under Erysiphe, and as the oidium and pycnidium of Vine Mildew, and the same growths belonging to Erysiphe communis (Sch.), appear to be identical—that is, they appear identical as far as these fungoid growths constantly varying within certain limits can be identical, so on these grounds is the European Oidium Tuckeri regarded as being an immature condition of *Erysiphe communis*—a widely distributed species of fungus found on quite a number of plants, but never, in England at least, on the vine, and it is considered, therefore, that each summer it arises from the germinating spores of this fungus—*Erysiphe*—rather than from a perennial mycelium developed by the Oidium itself.

In America it is now generally considered that the Oidium of the vine there is the early condition of another fungus, *Uncinula spiralis*. This conclusion is based on the researches of Mr. Thomas Taylor, detailed in the *American Monthly Microscopical Journal* for January, 1884, and is the one adopted by Dr. W. G. Farlow, in his paper on "The Peronospora and Uncinula of the Vine," as well as by F. Lawson Scribner, in his "Fungus Diseases of the Grape Vine."

No light has been thrown, until quite recently, on the nature of the mature form of the Oidium which infects Australian vines, it having been tacitly assumed that the latter is identical in its life's history with either the American or European forms. Thus the Secretary for Agriculture, Victoria, in his Annual Report for 1873, reproduces figures of the *Uncinula spiralis*, doubtless from some American work, and refers to these as representing the adult form of the Australian fungus.

During the present year Messrs. Cooke and Massey have described, as occurring on diseased grape leaves, forwarded by Baron von Mueller from the vicinity of Melbourne, the adult form of the vine Oidium, which they name Erysiphe vitigera. This is quite different from Uncinula spiralis, and also from Erysiphe communis, the sporangia of the latter containing from four to eight spores, while in this new species they only contain two.†

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* First Annual Report of the Secretary for Agriculture, Melbourne, 1873, pp. 76 and 78.

† The following is a literal translation of the description given of this fungus:—Amphigenous; mycelium floccose, persistent, conceptacles (perithecia) gregarius, minute (4 mm. in diameter), spheroidal; appendages obsolete, or interwoven with the mycelium; sporongia (asci) pyriform, four in each conceptacle, 50 by 30 micro-mil., two-spored; spores elliptical, hyaline, 18 by 9 micro-mil.—"*Some Australian Fungi*," by M. C. Cooke, Grevillea, June, 1887, p. 98.

Concerning this *Erysiphe vitigera*, Dr. Cooke remarks that it is "apparently distinct from all the bi-porous species. We have seen the floccose mycelium before, but without perithecia. Hitherto we have not been successful in detecting or identifying the conidia. . . . . . . Leaves and twigs sent to us from Australia last year, with a thick cottony white mycelium, but without fruit of any kind, was probably the same species. . . . . There is no evidence on which to connect it with Oidium Tuckeri, but, on the contrary, the floccose mycelium is much more woolly, and commonly sterile—at least, in so far as we have seen specimens. . . . . . . Destructive to vines in Australia. It has every appearance of being a dangerous pest. The methods adopted here of sulphuring Oidium Tuckeri should be tried perseveringly, and the disease stamped out at once if possible." *

From this it would appear that Dr. Cooke had no previous knowledge of the existence of an Oidium on vines in Australia, comparable with the well known Oidium Tuckeri; and that for this pest the treatment advocated by him had long been in use in the colonies. These are, however, facts generally known here. It is improbable that there are two vine fungi in Australia which have, like the Erysipheæ, an Oidium phase, and his researches seem to point to the conclusion that our Oidium, since it differs from the corresponding vine fungus of other countries, is indigenous to Australian soil. Dr. Cooke, however, had not, at the time he wrote, met with the conidia-bearing phase of Erysiphe vitigera; but from what he states there can be no doubt but that as compared with this phase—named Oidium Tuckeri—in the European vine fungus, it would have a more floccose mycelium, or a mycelium which, being floccose, would be more woolly, than had this latter.

As hitherto we have assumed that the Oidium of Queensland vignerons is identical with the well-known Oidium Tuckeri, we have not until recently critically examined it; neither have our observations been conducted during the autumn months, when alone, probably, the mature form is developed. Moreover, we are without means of comparing true specimens of Oidium Tuckeri with the form of vine-mildew common in Queensland, and the descriptions of the former are not sufficiently comprehensive to serve the purpose of such specimens.

Saccardo, writing of the European fungus, describes the mycelium of it as being effuse, cobwebby, pruinose, whitish, and the conidia as ovoid or ellipsoidal, and united together in a moniliform manner.† Again, H. H. Marès (in his "Manual for the Sulphuring of Diseased Vines." *Eng. trans.*, p. 232-3) thus, in part, describes Oidium Tuckeri:—"The filaments of the mycelium are from three to five-thousandths of a millimetre in thickness . . . . The tigelles (conidia-bearing branches) have a diameter of four or five thousandths of a millimetre in the narrowest part, at the base;—it is often double that at the top. Their length varies from seven to fifteen hundredths of a millimetre. The spores are of variable sizes—in general their largest diameter is twenty-five thousandths of a millimetre; it is often less. Their smallest diameter is about ten thousandths of a millimetre."‡

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* *Op. cit.*, *l. c.*

† *Sylloge Fungorum*, vol. iv., p. 41. Batavia, *Eng. trans.*

‡ It is interesting to compare with this description, from the point of view which regards the magnitude of parts of these fungi, that given of the oidium phase of the Uncinula spiralis of America. It is as follows:—"The dimensions of the various

From an examination of the conidia-bearing form the fungus as it appears in Toowoomba, in November, we are enabled to state that it is decidedly pruinose, and (at least on young grape-berries and their pedicels) flocculent rather than cobwebby. The mycelial threads are minutely and irregularly papillose; the conidia-bearing branches measured from 137 to 162 micro-millimetres (although some were much less) and never, as far as our observations proved, bore at one time more than three ellipsoidal conidia; but as the conidia are so readily detached these "tigelles" are usually distally truncate; they gradually increase in breadth from their base upwards; the conidia measured from 27 to 37 micro-millimetres by 20 to 25 micro-millimetres.

The vines of the Toowoomba district are subject to the injuries occasioned by this pest to an almost incredible extent. We directly traced the severity with which in places it manifested itself to neglect of the most elementary teachings of agricultural science. Given vines planted at too short a distance apart, and on this account—or owing to the rampant growth of weeds amongst them—offering every obstacle to the free admission of air and light; and vines exposed to the full force of the dry westerly winds without the semblance of a shelter, and we have the two main conditions which determine the presence of the Oidium with its full destructiveness. The accuracy of this relation between cause and effect was illustrated everywhere in the district, although there were other but less energetic causes which contributed to the same result. From our limited observations it would appear that the following grapes are those which are most addicted to the Oidium—viz., the Black Spanish, the Black Hambro', Shiraz or Hermitage, Red Moscatel, Black Moscatel, White Moscatel or Frontignan, and Yellow Safrina. Those which are only moderately affected by it are Royal Ascot, Black Hamaritch, Brown Moscatel, Green Safrina, White Safrina, White Frontignac, White Sherry, Riesling, and Wardilla. It might, however, be inferred that grapes of the *Vitis vinifera* type alone suffer from Oidium. This is not altogether the case; some American grapes also take it. Although nowhere during our visit did we see the Isabella attacked by this fungus pest, and it is generally regarded as blight-proof, yet this season (1888) Mr. G. Searle has forwarded us a bunch and leaves of this grape which are undoubtedly attacked by Oidium.* The Iona is, however, quite free at present from its attacks, and so are all the other American grapes, save only, as was pointed out to us by Mr. C. H. Hartmann, the Lenoir and Norton's Virginia—both belonging to the *V. æstivalis* type. We would, however, especially point out that this classification of the leading grapes grown at Toowoomba, according to the degree of intensity with which they are attacked by Oidium, will probably be

points of *Uncinula spiralis* are: Diameter of mycelial threads, 3-5 micro-millimetres; height of conidia-bearing branches, 80-150 micro-millimetres; size of conidia, 10-15 micro-millimetres by 25-30 micro-millimetres."—"*Fungus Diseases of the Grape Vine*," by F. Lawson Scribner, p. 24. Note.—For the European Oidium Tuckeri, again consult also Sebastiano Rivolta, in "Dei Parassiti Vegetati," 2nd ed., pp. 537-8, f. 265. Torino, 1884.

* Mr. F. M. Bailey informs us that some years since he noticed an Isabella vine which was growing at the General Hospital, Brisbane, infested with Oidium. In California it is commonly observed supporting this fungus, and according to Dr. Farlow it was from cultivated grapes of the same V. labrasca type that the original specimens, upon which the species Uncinula spiralis was founded, were procured.

subject to emendation when experience shall have thrown more light upon the subject; and that intending vignerons should not attempt to avoid the Oidium by allowing themselves to be guided in their selection of vines by it, otherwise they will have to discard some of the best grapes; but rather be fully prepared to contend with the Oidium by good cultivation and the adoption of the remedies which have been found useful in coping with it.

The Sulphur Remedy.—In sulphur we have a means of destroying the Oidium fungus. Its action depends on the fact that at temperatures ranging from between 75° to 95° F.—viz, at those temperatures which are most favourable for the development of the fungus—slow combustion takes place and it gives off sulphurous acid fumes. With reference to the sulphur itself, all samples which have an acid taste should be eschewed, for the presence of this character is an indication of the fact that they contain free sulphuric acid, since, as Professor E. W. Hilgard has remarked: "It is quite certain that if any sulphur so contaminated were introduced into an open grape flower it would effectually destroy the vitality of any pollen or pistil touched by it."* The same authority remarks: "As regards the choice between ground and sublimated (French) sulphur, the two are, doubtless, of equal efficacy when made equally fine, and, while differing in price considerably for equal *weights*, there is in reality little difference in the cost of equal *bulks*, which is the practical basis of comparison. Both the touch and microscope show that the ground sulphur is prevalently much coarser than the sublimated, and the relatively large, smooth, shining fragments of the former roll off, and are blown away from the leaves much more easily than the minute rough, roundish grains of the sublimated." (*Op. cit.*, p. 139.)

The best methods for applying the sulphur are those which were arrived at by Marès, and related by this authority in his "Manual of the Sulphuring of Diseased Vines." These have been but little modified since the date of his work, and the means for its application are the use of the sulphuring bellows or dredge, according to circumstances. The former is an apparatus already well known in the Toowoomba District. The sulphur bellows used there is certainly an improvement on the "Vergnes bellows" described by Marès, but does not, however, equal Campbell's Powder Distributing Bellows. (*Vide* Appendix—in which this and other suitable apparatus are treated of.)

The dredge merely consists of a handful or two of sulphur tied up in a muslin bag or enclosed in one or other of such special apparatus, as, according to M. Marès' observations, better subserve the same purpose. This authority on sulphuring diseased vines, however, describes these dredges as fatiguing and troublesome to the workman, as accomplishing their work slowly, as badly distributing the sulphur, and as causing great waste.

Authorities differ as to the time of day during which the sulphur should be applied to the vines, and the condition of the latter most suitable for its application. In his general instructions for the sulphuring of vines contained in the "First Annual Report of the Chief Executive Viticultural Officer," at pages 57 and 58 of that publication, and reproduced at page 163 of the "Second Annual

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* University of California, College of Agriculture. Report of the Viticultural Work during the seasons 1885 and 1886. Sacramento, 1886, p. 138.

Report," Mr. C. A. Wetmore states as follows:—"The sulphur should be applied in *warm dry* weather . . . . Do not apply when the leaves are wet. . . . . Repeat applications which have been rendered useless by rain, without delay, as soon as the weather is warm and dry." Professor Hilgard, on the other hand, states: "The mode of application which preserves the sulphur on the leaves longest (viz., sulphuring while the dew is on them) is certain to be the most effectual, the long continued contrary practice of old viticulturists notwithstanding"; and, "Regarding the mode of application, I have previously given my reasons for preferring to have sulphuring done while the leaves are moist with dew. The powder then remains adherent to the leaves, instead of being blown away by the first wind; and thus the disinfecting action is maintained for a length of time."*

Finally F. Lawson Scribner states:—"The time when the sulphur should be employed is in early summer, at the first appearance of the mildew, and the application is most effective when made on a warm bright day, after all the dew is evaporated. However well this application may be made, it is almost certain that some of the fungus threads and many of the conidia will escape destruction. From these, or from spores brought from other vineyards, a new infection may appear in from twenty to thirty days, when a second sulphuring should be made. In districts particularly subject to the disease it is recommended that the vines be sulphured, first, when the young shoots are about four inches long; second, at the time of blossoming; third, some days before the turning of the berries. In bad seasons the mildew may make its appearance between these periods; when, of course, additional sulphuring should be made."† The common practice in Toowoomba, wherever sulphur is adopted, is to mix the sulphur with lime. Mr. Heissle, of Hume Street, stated that he mixed for this purpose two bushels of lime with 136 lbs. of sulphur, and applied the mixture, by means of the bellows, to the vines four times during the season, with, as was plainly apparent, very beneficial results. American authorities, however, recommend simply the use of sulphur alone, and do not suggest that it be mixed with lime or with other bodies such as, for instance, the *minerale greggio* so much in favour for oidium in Sicily, and referred to in the "First Annual Report of the Secretary for Agriculture," Melbourne, 1873, p. 79. In a similar manner they advocate its use in preference to the well known "eau grison" or "polysulphuric grison"—made by "boiling three pounds each of the flowers of sulphur and lime, in six gallons of water until reduced to two gallons. When settled, the liquid is poured off and bottled for use. One pint of this clear solution in twelve gallons of water is the strength recommended" (*Scribner*). This fluid is applied to the vines by means of a pump and cyclone nozzle.

BLACK SPOT OR SCHWARZE BRENNER (*Sphaceloma ampelinum*, De Bary).

The vine disease known throughout Australia as the Black Spot, was observed to be very prevalent at Toowoomba at the time of our visit. It was observed on the Riesling, the White Moscatel, the Watilla, and the Sweet Water. Mr. G. Searle also has forwarded us

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* "Report on Viticultural Work during the seasons 1885 and 1886." University of California, College of Agriculture, Sacramento, 1886, p. 138.

† "Fungus Diseases of the Grape Vine," pp. 27 and 28.

specimens of the following grapes affected by this disease—viz., Buckland's Sweet Water, which he states to be "one of those grapes most subject to Black Spot in all seasons;" the White Syrian which he has observed "to be more susceptible to Black Spot in Toowoomba than in any other place," and the Green or White Solferino which is now (in 1888) seriously affected by Black Spot, although it has never been within Mr. Searle's previous experience to find this grape attacked by the disease. The Black Spot more frequently occurs on the White Grapes than on others, although the Red Moscatel is also addicted to it. We have received specimens of this variety from Mr. Searle, and they bear out his statement, that they are very much subject to Black Spot. Amongst the American cultivated grapes it is met with at Toowoomba, as Mr. Hartmann informed us, on both the Lindley and the Gœthe. Dr. J. Bancroft has found it very bad on Lenoir. Black Spot as a disease of the vine, was known in Australia as far back as 1862, if not at an earlier date, although we are not aware that its precise nature has ever been ascertained. More recently it has been observed in America, in the first instance in Central Illinois, where it was found to exist in 1881. American writers regard it as an importation from Europe, and it is probable that Australia has received it from the same source. Those Toowoomba settlers who have made their early acquaintance with the vine in the Rhine Districts designate this disease the *Schwarze Brenner*, a malady of the vines known to be caused by Sphaceloma ampelinum, and miscroscopic examination establishes the fact that this title which they have bestowed is a correct one, and that Black Spot and Schwarze Brenner are one and the same disease, being both due to the presence of the above-mentioned fungus.

Symptoms.—Black spot is too well known amongst grape growers in these colonies to need a very minute description of the symptoms which characterise its presence. *On the shoots*—dark brown, nearly black, spots appear on the young branchlets and tendrils, which are elongated in the direction of the growth of these organs, and it will be observed that the tissue immediately beneath the epidermis, in which these are situated, is destroyed so that the general surface is interrupted by a depression which extends to the central bundle or woody tissue. An appearance is thus presented similar to that which might be expected to arise from the application in drops of an intensely active corrosive liquid. Where several of these spots occur together to form a single blotch and the epidermis of the stem has made some efforts in its growth to encroach upon it, it seems as if the tissue had been gnawed into by an insect.* *On the young leaves.*—The disease first appears as light-brown, eventually becoming darker, irregularly shaped, even bordered, blotches without any noticeable depression in

* The above description relates to Queensland examples of vines affected by Black Spot. M. F. L. Scribner thus describes the appearance of a disease which he writes of under the name *Anthracnose*, and which—although he makes no mention of the term Black Spot—is identical with the one before us: "There first appear (on the shoots) minute brown spots, a little depressed in the middle, with a slightly-raised darker-coloured rim or border. These spots soon increase in size, elongating in the direction of the striæ of the bark, the central portion becomes more evidently depressed, and usually takes on a greyish hue. The bark is finally destroyed, and, in severe cases, the woody tissues beneath appear as if burned or corroded, so deeply sometimes as to reach the pith."—*Report on Fungus Diseases of the Grape Vine*, p. 36.

the surface of the tissue. These are from 1 to 2mm. in breadth, but they afterwards increase until they have a diameter of a quarter of an inch or more. As the leaf grows these spots of altered tissue may be broken through, owing to distention caused by the development of the adjacent parts.* *On the berries.*—The spots are at first circular, very light-brown, and scarcely perceptible, measuring only 0.5 mm. ($\frac{1}{48}$ inch) in diameter. Then they enlarge in size, and become dark-brown (nearly black), with a lighter coloured central depressed area. Several spots may become confluent, forming irregularly shaped blotches, with rounded borders, which may measure $\frac{1}{4}$ inch in diameter. Each blotch, however, shows its compound origin, and the shallow depresssion of each component spot may still be observed, for a malleated appearance of the whole area is usually persistent. The portion of the surface of the grape occupied by each blotch also becomes depressed, and thus the regular contour presented by sound fruit is interrupted, and its symmetry destroyed. The spots occur all over the berry, and may be very numerous. There is frequently a large one just above the insertion of the pedicel, and smaller ones on the pedicel itself. "Under the action of the disease, the berries begin to wither and dry up, leaving nothing apparently but the skin and the seeds. . . . . But the circular spots first formed are easily seen, and the colourings characteristic of the disease are retained. A berry . . . . . attacked upon one side when it is not more than half grown . . . becomes irregular in shape, the diseased part making no further development; and it sometimes happens that this side cracks open, exposing the seeds, which are gradually forced out by the unequal growth of the berry."—*Scribner.*

The fungus.—The central portion of the spot is of a greyish colour, and this appearance, the microscope shows, is due to the presence of minute heaps of white granular matter, consisting mainly of the spores (conidia) of a fungus. Each heap of fungus is made up of a little group of cells situated beneath the epidermis, where it forms a little mass of exceedingly fine parenchyma. The most superficial cells of this group are slightly apiculate, and each of these bears a solitary oblong elliptical or ovoid clear spore, with two yellow oil-like globules, one towards either extremity. The little groups are placed close one to the other throughout the spot. The minute greyish white specs on the spot are each opposite one of the little heaps, and mark the situation where the spores and the spore-bearing cells (basidia) of which they are composed burst through the surface as the fungus develops.

The fungus of the Black Spot of Queensland agrees pretty closely with Lawson Scribner's description of what he has decided is the Sphaceloma ampelinum of De Bary,† and also with the characters assigned by Saccardo to Glœosporium ampelophagum (Pass) Sacc., with which the former authority identifies it.‡ It differs, except in the important character afforded by the spores, in which they agree, as much nearly

* "The appearance and action of the fungus on the leaves is similar to that upon the stems."—*L. S. Scribner.*

† *Vid. Op. cit.*, p. 37.

‡ This fungus is thus described by P. A. Saccardo : "Maculis seu pustulis (in baccis, rarius in foliis et sarmentis adhuc vivis plurium varietatum præcipue fructu albo, Vitis viniferæ), subcircularibus, sæpe confluentibus, baccarum epidermidem

from the figures given by these writers as representing these two fungi as do these figures one from the other. However, these representations do not, either of them, strike us as being very accurately made. Saccardo's is contained in "Fungi Italici Autigraphice Dilineati," Melanconiæ, 1030, Batavia, July, 1881, and Scribner's in his "Report on Fungus Diseases of the Grape Vine," plate vi.

Remedies.—In Victoria it is the practice where Black Spot occurs to cut back those vines in which it is met with to a much greater extent than would otherwise be done, or to graft upon them scions from vines which experience has shown are not subject to this disease—at least in the particular district concerned. Mr. G. Searle, of Toowoomba, has, in a vineyard of mixed grapes, used lime and salt as manures successively in different years, and has applied them in combination, also, in both cases, with good results. In Europe quite a different practice is adopted, which has the advantage of including in it one of the operations employed as a preventative for Oidium, which it is desirable should be the case as some vines, such as the Red Moscatel, the White Moscatel, and the Wardilla, ... take Black Spot and Mildew simultaneously. Lawson Scribner thus describes this method:—"The practice is quite generally followed of bathing or washing the vines, in early spring, before the buds have commenced to expand, with a strong solution (50 per cent.) of sulphate of iron, applied with an ordinary mop or a large sponge fixed to the end of a stick two or three feet long. This washing should be done when the atmosphere is damp, in order to prevent a too rapid evaporation of the iron solution, which otherwise might result in injury to the vine. When the young shoots have attained a length of 5 or 6 inches, they receive a good dusting with the flowers of sulphur, whether the disease has appeared on them or not. The new growth is then carefully watched, and at the first sign of the malady they are again treated, this time with sulphur to which has been added one-third to one-half its bulk of powdered lime. If the progress of the disease is not checked by this treatment, the sulphur is omitted in subsequent applications which are of finely pulverised lime."* Sulphur alone, as Mr. G. Searle also informs us, acts neither as a cure or preventative for Black Spot.

LEAF SPOT (*Helminthosporium viticolum*, Sac.).

This disease is by no means uncommon in the Toowoomba district. It also occurs on vines growing in and near Brisbane. In the latter locality it has for some time past been an object of investigation to Dr. J. Bancroft.

Symptoms.—The lower and more shaded leaves are covered to a greater or less extent with rounded or irregular brown spots, varying usually in size from $\frac{1}{24}$ to $\frac{1}{8}$ of an inch in diameter, though they may

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strataque corticalia occupantibus, et arescendo indurantibus atque rufro vel fuligineo nigricantibus, ad centrum (e conidiis exsilientibus) griseo vel roseo-pruinosis; acervulis sub-epidermide nidulantibus, minutis dense gregariis, strato proligero pulvinato minute parenchymatico, hyalino v. dilute fumosa cellulis superficialibus vertice breve apiculato spongeris; conidiis ex oblongo ellipsoideis v. ovoideis, 5-6 by $2\frac{1}{2}$-$3\frac{1}{2}$ micro-millimetres, 2-gutulatis hyalinis." *Sylloge Fungorum*, vol. iii., p. 719, Batavia, 1884; also in *Michelia* i., p. 217. *Ramularia ampelophaga*, Passerini, Nebb., Moscat, 1876. *Phoma uvicola*, Arcang., non Berk. et Br.

* *Op. cit.*, p. 38.

be much larger. These have a clearly-defined darker coloured, often purple, slightly thickened or elevated border. The diseased areas may also be seen on the under surface of the leaf, for they involve its entire thickness.* Usually the portion of the leaf surrounding them is more or less yellow in colour.

Cause.—If one of these spots as it occurs on the under surface of the leaf be examined by the aid of a microscope of low powers, it will be observed to be studded with little tufts of dark olivaceous-coloured linear bodies, and that these tufts arise from the stomata or breathing pores of the leaf. If one of the tufts be further examined it will be seen to consist of linear tubular septate bodies (Hyphæ), which at their blunt extremities support elongated spores. The latter are narrowed towards their bases of attachment, and widened and blunt at their opposite ends; they are divided by septæ into few or several cells (from 3 to 13—Scribner), and vary considerably in length (30–90 micro-millm.—Scribner). These appearances constitute the outer manifestation of a fungus disease; the fungus itself arises from threads or mycelia, which spread and feed within the leaf-tissue itself.

As a rule, this disease is not made a ground of complaint, the spots being regarded as being due to sun-scalds. When, however, the spots are very numerous, there can be but little doubt that the exercise of their functions by the leaves is considerably affected by their presence.

At Brisbane we have very frequently noticed the presence of the Bryobia Mite on the leaves of vines subject to this disease, but have been unable to trace any connection, such as appears to exist between it and the Brown Mite (p. 160), between the two occurrences—(*Vid.* "Bryobia Mite," under "Peach," p. 92.)

CHAPTER VII.

Vegetables.

CABBAGE, TURNIP, &c.

Cabbage Aphis (*Aphis brassicæ*, Linn.).

An Aphis does much damage to cabbages at Toowoomba, and is also a cabbage pest in the neighbourhood of Brisbane, and probably at many other places in the colony. We have compared specimens of it with the descriptions given by different authors of *Aphis brassicæ*, and have no doubt that our Cabbage Aphis is this insect. The two forms of the aphis, which alone have as yet been observed, are thus described:—

"*Wingless viviparous Female.*—This has rather a long oval body, covered with a whitish mealy coat. When this coat has been removed by immersion in alcohol or otherwise, the body is seen to be of a greyish-green colour, with eight black spots down each side of the back, increasing in size towards the posterior end. The antennæ are green with black tips, and are shorter than the body, and the eyes, legs, and tail are black.

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* This description of the appearance due to disease is derived, in part, from F. L. Scribner's "Report on Fungus Diseases of the Grape Vine," p. 39, and accords with what is observed on Queensland vines.

"*The young* when first hatched are oval, shining, bright-yellow in colour, and lack the mealy coat.

"*Winged viviparous Female.*—This is yellowish-green coloured, with the eyes, head, neck, and thoracic lobes black, and the antennæ and nectaries dark-brown; the legs are dusky brown and hairy; the tail is dark-green or brown, and also hairy; the wings are rather short, with stout, coarse veins, and dark stigma."*

Remedies.—(See under "Peach Aphis," p. 83.) C. Whitehead states as follows: "Washing the plants with a decoction of soft soap and quassia, in the proportion of 7 or 8 lbs. of soft soap, 7 or 8 lbs. of quassia, and 100 gallons of water, is almost a certain cure if carried out properly. This may be applied with the washing engine with pump and hose and cyclone nozzle attached. It should be stated here that it is necessary to use soft soap, or some composition of this nature, in all washes adopted as remedies for aphides, in order to fix the wash upon their bodies. This is especially necessary in the case of the *Aphis brassicæ*, the bodies of whose larvæ are thickly covered with a downy or mealy substance. This washing is an expensive process, and would cost from £2 to £3 per acre."†

Not only is Aphis brassicæ destructive to cabbages and turnips, but also to several weeds belonging to the same natural order—Cruciferæ. These harbour it at all times, and help to make the abode of the pest in any one district a permanent one.

SMALL CABBAGE WORM (*Plutella cruciferarum*).

Symptoms.—This pest is a pale green cylindrical caterpillar measuring about a quarter of an inch in length. It may occur in numbers upon the cabbage or turnip, and eat the leaves of these esculents until they are completely riddled with holes. Only the expanded outer leaves of the cabbage are as a rule injured by it, the compact inner head being left untouched, but in those varieties—such as the Savoy—which do not form large and compact heads, the cabbage is utterly ruined. The caterpillar is the early stage of a somewhat diminutive moth. The following particulars relate to this insect:—

The Moth.—This varies in colour in different specimens, but is usually ashy-grey. The fore-wings are fringed on the outer edge, and the hind-wings have a continuous fringe along their outer and posterior margins. The costal or anterior border of the fore-wings has a few pale-coloured marks towards its apex; but these are sometimes wanting. Along the posterior border there is a continuous pale band which has angular forwardly directed prolongations. This band, when the wings are folded, gives rise to the appearance of diamond-shaped patches. The hind-wings are uniformly coloured and lighter than the fore-wings. The antennæ are long and white. In length of body the moth is from five lines to 1½ inch, and it has a wing expansion of seven lines or more. The sexes vary somewhat in appearance, and might be regarded as being distinct species were their relationship not known.

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* *Report of the Entomologist.*—Report of Commissioner of Agriculture. Washington, 1884, p. 318.

† "Reports on Insects Injurious to Root and certain Other Crops," Lond. 1887, pp. 63-64.

The Caterpillar.—This is cylindrical, tapering towards each extremity, and has sixteen legs. It is of a light-green colour with a yellowish tinge here and there, and has an ashy-grey head. It attains a length of a little over quarter of an inch.

The Chrysalis.—The chrysalis itself is ashy, or grey-coloured, with a few small spots upon it. It is contained in a very delicate gauze-like cocoon, and is placed upon the food-plant.

Habits.—The eggs are deposited in little masses upon the food-plants; the caterpillars are very active, wriggling violently and dropping by a silken thread when molested. The moths may be readily distinguished as they flit amongst the affected cabbages, and suddenly alight and run quickly over the leaves. In settling they direct their downwardly inclined wings backwards, and so assume an elongated form. Meanwhile the antennæ are held forward in a line with the body. As in other countries so also in Queensland, the caterpillar of the cabbage worm will feed upon the leaves of the turnip, and also on those of several other *Cruciferæ*, and especially on the plants of this order which grow as weeds in and about cultivations. It would seem that the pest is continuously reproducing itself during the prevalence of the special climatic conditions favouring its existence. In some seasons it is a much more formidable enemy to the cabbage grower than in others.

Occurrence.—Mr. E. Meyrick has stated that the *Plutella cruciferarum* (Zeller) occurs throughout the whole world, from Greenland to New Zealand.* The works of economic entomologists issuing from England, Germany, France, and the United States of America have all a portion of their contents devoted to this pest. In England it is known as the Turnip Diamond-back Moth—*Cerostoma xylostella.*†

Its occurrence in the neighbouring colony of New South Wales does not appear to have attracted notice until 1882, for in March of the following year the Hon. W. Macleay exhibited at a meeting of the Linnean Society of New South Wales "specimens of a small moth (which was afterwards identified with the pest under consideration), the larva of which was creating great havoc in the vegetable gardens in and about Sydney, completely eating up the leaves of the cabbages and cauliflowers and rendering the entire crop utterly useless."

When this pest was first introduced into the neighbourhood of Brisbane cannot be ascertained. Those who have been interrogated on the subject have generally stated that they have known of its existence here for a number of years. It is, however, a significant fact that no mention is made of its existing in the colony, either in 1876-7-8 or -9, in which years the "Reports" emanated from the "Board appointed to Inquire into the Causes of Diseases affecting Live Stock and Plants"; although the Cabbage Aphis was stated to occur in every district.

With regard to Toowoomba, in which locality it is now a recognised enemy of the cabbage, Mr. B. Crow, senr., informed us that he saw nothing of it when he was growing cabbages there ten years since. Mr. G. Searle, too, has stated that he has no recollection of having seen it in that district earlier than five or six years ago.

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* Proc. Lin. Soc. N.S. Wales, viii. 1883, p. 282.

† *Vide* Charles Whitehead in "Insects Injurious to Root and Certain other Crops," 1887, pp. 55, 59; and other authorities.

The latter observer met with the pest, or one very similar to it, at Maryborough already in 1882. We have not heard of its occurrence in the western districts as yet, although the Cabbage Aphis is spoken of as being met with as far back as Surat.

The *Plutella cruciferarum* is conveyed from one town to another upon cabbages, and especially is this done by the passenger steamers —the servants on which do not always empty their refuse bins into the sea.

Remedies.—It has been stated that lettuces grown amongst cabbages will protect the latter from the attacks of the pest; but those who have pursued this course in Brisbane have not found any benefit to result from the practice.

In dealing with cabbage-worms (the large caterpillars of butterflies —Pieridæ, and of noctuid moths) the United States Entomologist has remarked as follows:—

"Every worm visible upon the cabbages may be killed by the use of water at the temperature of 130° Fahr., or 55° C. The water may be boiling-hot when put in the watering-can, but it will not be too hot when it reaches the cabbage leaves. The thick, fleshy nature of the leaves enables them to withstand considerable heat with very little injury. The sacrifice of a few heads of cabbage will soon teach an experimenter how far he can go with the hot water. It may be sprinkled over the plants with a fine-rose watering-can, or poured on with the sprinkler removed. If it is very hot it will colour some of the leaves, but even where the cabbage is considerably scalded it will recover and renew growth from the heart. . . . . Where hot water cannot be applied readily, the most efficacious remedy is the application of cold water with which has been mixed a small quantity of Persian insect powder, or Pyrethrum. Two hundred grains of powder may be mixed with two gallons of water, or in the proportion by weight of 1 to 600, and the mixture sprinkled or squirted on the plants."*

London Purple is another substance which has been successfully used in contending with cabbage worms in America, especially when applied in the dry state, mixed with flour or dust. The proportions recommended are 1 part of London Purple to 100 parts of the diluent. The resultant powder must be scattered by means of an ordinary powder-distributing apparatus.

Concerning the possible danger attendant on the employment of an arsenical preparation, we can only quote the opinion and experience of one who has used it. Cap. R. S. Lacey, of Washington, has remarked that "it is a delicate matter, of course, to urge upon others the use of any poisonous applications, but I am so thoroughly convinced of the absence of danger involved by mixing London Purple with flour or dust in the proportions specified that I feel free to speak of my practice with it. . . . . London Purple, too, no matter where put, will not remain under the washings of dews and rains (much less those of the watering can.—H. T.) for the period of a week. . . . . . Killing cabbage pests simply means persistent and continuous effort."†

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* "Report of the Com. for Agr., U.S.A., Report of the Entomologist," 1883, p. 131. With regard to the powder of Pyrethrum, it must be borne in mind that this varies very much in quality, insomuch so that some samples might be used without effect. The plant might be grown in the colony.

† Report of the Com. of Agr., U.S.A., 1883, p. 134.

Cabbage-eating Caterpillar.

Mr. G. Searle, in reply to inquiries concerning a cabbage-eating caterpillar which had been reported as damaging the young plants, states as follows :—

"A small cream-coloured grub attacks young cauliflower plants. It begins eating when so small as to be almost invisible to the naked eye. It sometimes eats a hole in the upper side of the base of the petiole or leaf-stalk, but more often eats into the heart of the plants and down the inside of the stem, always feeding on the soft tissue of the centre of the stem or leaf-stalk. It cocoons within one of its burrows, covering the entrance thereto with web ; but occasionally within the rolled up withered leaf. It never does any harm to plants after they have acquired six or eight leaves."

No opportunities for a personal investigation of this injury have occurred.

Remedies—Mr. Searle states that he has found a "decoction of soot" to keep plants free from this pest.

The same observer has also stated that he was first troubled with this cabbage insect whilst at Pilton, Darling Downs, during 1875 or 1876, and that at the time he wrote to the "*Queenslander*" describing it and advising others to keep a sharp look out for it on their young plants.

MELON, PUMPKIN, AND CUCUMBER.

INSECT DISEASES.

Brown Galeruca (*Galeruca*, sp.).

This is a small, oblong, yellowish-brown, smooth beetle, measuring about ¼-inch in length, with the hind extremity rather widened. The following description will serve to identify it :—

Galeruca, sp.—Above, uniform light-yellowish brown ; beneath with metathorax, abdomen, legs beyond femora, antennæ beyond first two joints, and front part of labrum, dark reddish-brown ; upper surface glabrous ; under-surface, legs and antennæ, pubescent. Head less broad than prothorax ; vertex and front without mesial impression, or a slight one only on the latter. Labrum rounded in front, with a shallow mesial emargination ; a few stout hairs on anterior border. Mandibles dark-brown, with four stout teeth, of which the terminal one is long and sharp, and the remaining three progressively, towards the base, less sharp. Antennæ 11-jointed, filiform, yellowish horn colour at base, darker distally ; first joint incrassate towards distal end, about equal to second and third together ; second joint short ; third joint scarcely longer than the fourth or succeeding ones, which are sub-equal ; terminal joint apiculate. Prothorax broader than long, with a transverse impression dividing it into two equal portions, of which the anterior is somewhat convex, margined ; sides arcuate. Elytra oblong, slightly broader posteriorly ; epipleuræ little developed and continuous to the hind margin. Prosternum hidden between anterior coxæ, which are contiguous, anterior cotyloidal cavities closed behind by a narrow border. Metasternum without prolongation between middle pair of legs. Claws strongly bifid, inner division the smaller ; length, about 3 lines.

It is a very active insect, and readily takes wing when approached. It usually feeds upon the leaves of pumpkins and melons, and upon those of other cucurbitaceous plants, and may become quite a formid-

able pest. In November, 1886, Mr. D. Simson, of Telemon, Hughenden, remarked, whilst forwarding specimens of the Galeruca, that "these insects have completely destroyed all pumpkins, melons, vines, sweet potatoes, and are now on the cabbage."

Remedies.—We would recommend that the leaves be dusted with a mixture of fine shell-lime and ashes whilst the dew is upon them, and so rendered distasteful to the beetles (*vid.* p. 5.) As the adult grub undergoes its changes in the soil, advantage might be taken of this fact to attack the beetle before it emerges.

Banded Galeruca (*Galeruca*, sp.).

A second species of beetle closely allied to the preceding is equally destructive with it, especially in Southern Queensland.

It may be distinguished by its smaller size, by its abdomen being broader posteriorly, by its antennæ being suddenly narrowed and flattened after the fifth joint, by the possession of a strong impression on the fore-part of the front, by its keeled epistome, and by the following special colouration :—There is a broad black band across the base of the elytra, a second similar band—interrupted at the suture—midway between this and the posterior border; and the latter portion of the wing covers is also black. Beneath, the two or three first segments of the abdomen present the ordinary light reddish-brown colour of the remainder of the body.

When badly infested by this beetle the leaves of cucurbitaceous plants are reduced to a few shreds only, supported by the principal veins, and the latter, and even the stem itself, are in places gnawn into. When the injuries occasioned by the beetle have proceeded to such a degree as this, the survival of the plant itself may in most cases be despaired of.

Leaf Eating Beetle, No. 3.

(*Vid.* "Potato," *s.v.* *Epilachna*, p. 181.)

Pumpkin or Melon Aphis.

Mr. Donald Macpherson, of the St. Helena Penal Establishment, states that the melon plants growing there this season (1887) are being destroyed by a dark green aphis which feeds on the young shoots, and is also found infesting the under surface of the leaves. This aphis has not been previously noticed in that locality, and though no complaint concerning injuries occasioned by it in the Toowoomba district has been brought under notice, there is little doubt that it will extend its ravages there too at some future date. (*Vid.* Peach Aphis, p. 83-88).

FUNGUS DISEASES.

(1.) Leaf Mildew (*Oidium erysiphoides*, var. *cucurbitarum*).

Symptoms.—Attention is usually directed to the occurrence of this disease, in the first instance, by the fact that the margin of the leaves are somewhat turned inwards—a phenomenon, however, which only happens when the fungus has chosen the under surfaces on which to commence its attacks. At this early stage whitish patches will be observed. These soon extend and coalesce, until both surfaces of the

leaves are covered by a fine white powdery investment. This white material is the external manifestation of the Oidium itself. Ultimately the leaves attacked die gradually away, the young shoots beyond them wither up, and any fruit which may happen to be still young remains undeveloped.

The Oidium occasioning this damage to cucurbitaceous plants is a close ally to that one which causes the powdery mildew, or Oidium disease, of the vine. We observed that the pumpkins at Toowoomba were very subject to it, a fact which might to some extent be accounted for by the custom of raising them on ill-ventilated spots of ground between the ranks of growing maize. It also occurs in the neighbourhood of Brisbane, and generally perhaps throughout southern Queensland.

Remedies.—Doubtless sulphuring—the method adopted in contending with the Oidium of the vine—would be found efficacious in dealing with the leaf mildew of cucurbitaceous plants (*vid.* pp. 164-5). Its occurrence, however, might be prevented by the practice of better cultural methods than those now in vogue.

(2.) Fruit Rot (*Glœosporium cucurbitarum*, Berk. et Br.).

Symptoms.—In the case of this disease the pumpkin or melon after it is fully developed, and, often, even before it has been gathered, rots quickly away and its tissues degenerate into a soft grumous mass.

These changes have been ascertained, by Mr. F. M. Bailey, to be due to the growth of a special fungus which Messrs Berkeley and Broome have described as *Glœosporium cucurbitarum*.*

We observed the occurrence of this disease at Toowoomba—especially in the case of melons. As Mr. F. M. Bailey has remarked, its effects are most felt when it preys upon the fruits of cucurbitaceous plants kept as winter food for stock.

This curious disease, concerning which little is known at present, may be compared with that of apples and pears, which we have described under the name of "rot" (*vid.* p. 50).

Remedies.—Mr. B. Crow, of Toowoomba, informs us that the incursion of this disease might be prevented by frequently turning the melon during the later stages of its development, and so subjecting every part of it equally to the influence of the air and sun.

CHAPTER VIII.

Vegetables—*continued.*

THE POTATO.

INSECT DISEASES.

The Potato Grub (*Lita solanella*).

Our attention to the existence of this pest in the Toowoomba district was first drawn by Mr. G. Searle, of Rosehill Gardens. Our informant complained of an insect destructive to potatoes, after they had been dug up, which he described as a "miller." Mr. Bushnell, of

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* *Vid.* "Trans. Linn. Soc., London, Botany," vol. ii., p. 68.

Isaac street, to whom the subject had been referred, spoke of the insect as being a moth identical with the one which in previous seasons had infested cabbages—that is, with Plutella cruciferarum (*Zell.*), one of the family Tineina. Examples of injured potatoes, received from Mr. Searle, from which the mature insects were bred, soon confirmed us in our previous opinion that it was a pest already well known in the other colonies, and was the larva of the moth Lita solanella.

History.—In New Zealand—at least as long since as thirty-five years—an insect was reported as making extensive ravages in the potato tubers there, as we learn from Cap. H. Berthon who regarded it as being identical with one which did much injury to the potato crops in certain parts of Tasmania in 1854. From Cap. Berthon's description of the insect and the nature of its injuries, it is evident that he had in view the same pest which we are now considering.*

This potato grub must have shortly afterwards made its presence felt in Adelaide, South Australia, for J. G. O. Tepper relates, in writing in 1881, about the ravages of a moth, which Meyrick had identified as being this Lita solanella :—" Some thirty years ago, when practically connected with farming, I observed that during the first years the potato tubers kept well, and the loss through rotting was but trifling. But after that a change took place . . . and even many of those that appeared healthy were found, to the astonishment of the persons concerned, to contain a number of small caterpillars."†

In 1874, as we learn from E. Meyrick,‡ Lita solanella was "described by Boisduval§ as being very injurious to potatoes in Algeria," and that "in the succeeding year M. Rayonot, of Paris, abstracted|| the essential parts of his account and added some remarks of his own."

When it was first observed as a pest in New South Wales is, too, somewhat uncertain. Meyrick, writing in February, 1879, informs us that the Hon. W. Macleay, of Sydney, was "acquainted with the fact of its having occurred in abundance some years back, near Sutton Forest," and he then alluded to the occurrence in that colony, of a recent instance of the disease caused by this moth, at the same time stating as follows :—" I have satisfied myself that it is probably identical with Lita solanella."

When it first manifested its destructive habits in Queensland we are unable to certify, but for some time past rumours of complaints of some mysterious disease occurringin potatoes growing in the southern portions of the colony, and causing the tubers to "rot," have reached us. Mr. J. Philp, writing from Gatton, 2nd May, states, concerning experiences in that district :—" More than half the potatoes planted

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* "Papers and Proceedings of the Royal Society of Van Diemen's Land," vol iii., pt. 1, p. 76. Tasmania, 1855. This early notice of the occurrence of the "Potato Grub" in New Zealand and in Tasmania has apparently been recently lost sight of, but is of importance in tracing the whence of the infection of the potato crops in South Australia, New South Wales, and Queensland.

† Trans. and Proc. of the Royal Society of South Australia, vol. iv., p. 57. Adelaide, 1882.

‡ Proc. Lin. Soc. N. S. Wales, vol. iv., p. 112. Sydney, 1880.

§ J. B. Soc. Centr. Hort., November, 1874.

|| Bull. Soc. Ent., France, 5 (v.), pp. xxxv.-xxxvii.

on some farms have gone rotten in the ground."* A rottenness of the tubers is one of the ultimate conditions which characterise the progress of the potato disease due to the invasions of the Lita solanella.

An extensive literary research has failed to reveal any mention of the existence of this pest either in America or on the continent of Europe.

Description.—The Moth.†—This is "very insignificant in size; . . . . . . its length of body is about 6 mm. ($\frac{1}{4}$ inch), the span of the wings is 15·5 mm. for the female; the male is a trifle smaller. The colour of the whole insect is brownish grey, in various shades; the face of the head is almost white; the eyes large, dark-brown or black; the maxillæ are very large in proportion, being longer than the head, the middle joint of the three being beset with close hairs like a brush; the antennæ are very long and slender, equalling nearly in length that of the whole body; the joints very numerous and small, in the upper part showing a minute spinous projection. The anterior wings are straight, narrow, rounded at the end. The inner margin near the base is smooth for about three-fifths of the length, the last two-fifths furnished with long fringing hairs, longest inferiorly; the colour in the female is light brownish grey, mottled with very minute black and white specks, forming very indistinct bars. The colour of the anterior wings of the male is a rather clearer brown, the black mottlings forming a semicircle along the inner margin, and a kind of very small eyespot at the very end. The posterior wings of both sexes are perfectly alike, the membranous portion being of about the same width as the former, but about one-fourth less in length; colour brilliant silvery bluish white; this is fringed from the extremity to the base posteriorly with long silky brownish hairs; exceeding in length at the widest part the width of wing considerably, and so arranged as to form a semicircle. The three pairs of legs are all unequal; the first pair are the shortest, and not armed with spines, or very minute ones only; the last pair are the longest, exceeding the length of the body considerably, the shank or tibia armed with four strong spines below, and set with long, close stiff hairs above; the medial legs are intermediate in size, the spines reduced and the hairs wanting; the colour of the legs is nearly white, dotted sparingly with brown and black; the claws very minute. The same colour prevails over all the underside of the abdomen; the upper side is darker than the rest, a tuft of light orange hue at the extremity of that of the female distinguishes the sex easily."

The Eggs.—These are small white glistening elliptical bodies with a pearly iridescence.

The Caterpillars.—The caterpillar, when about fully grown, measures 11 mm. (about $\frac{4}{10}$ inch) in length. It tapers from the middle point towards each end. It has the usual thirteen segments, and three pair of thoracic or true legs and six pair of abdominal prolegs. Its colour is greyish white, with a faint tinge of pink beneath, an

* *Courier*, Brisbane, 2nd May, 1887.

† We have not access to Boisduval's original description, and therefore quote J. G. O. Tepper, premising that his statements concerning the insect have been checked by examination of numerous Queensland specimens, and found to be generally correct.

obscure indication of a narrow bar of the same colour on each segment above. The head, the shield of the first joint of the body and the thoracic legs are brown. There are a few weak white hairs—from twelve to fourteen—on each segment, the origin of each hair being marked—as seen by aid of a lense—by a minute spot.

The Chrysalis "is of a dark amber colour, little more than half the length of the full grown larva" (Berthon), length 6·5 mm. This is placed under a loosely felted web of greyish white silk, or in a cocoon of the same material. To the outer surface of the silken covering fragments of earth or rejected food material adhere or are woven.

Habits of Insect.—When fully established in a district, both those potatoes which are in the ground and those which have been removed from it and are stored are subject to the attacks of the moth. At Toowoomba, as far as we learn, it is only those tubers which have been dug up which, as yet, suffer.* Mr. G. Searle, in reply to our questions, remarks :—"I am perfectly sure that the insect is not in the potato while this is in the ground. We are almost daily using potatoes which were all dug at one time, immediately picked up, and placed in a dry-goods cask in which straw was placed between each layer of tubers. The cask is covered up by a corn bag, and with the exception of a few near the top of it, none are affected by the moth." In Tasmania it was "invariably found that the moth attacks the roots. The uppermost potatoes, those which are nearest the surface, are of course most easily reached, nor is it by any means a difficult matter for the insect to penetrate to the depth of three or four inches when the soil is open, uncompressed, or lumpy. Not a single case of an infected stalk has yet been detected; but constant and numberless have been the instances in which, when uncovering the potatoes at the depth just indicated, moths have been dislodged, and flown uninjured away." Of course some of these, however, as must have occurred to the author of these observations, might have hatched from pupæ still in the ground; but in anticipation of this objection he adds :—"The potatoes whilst lying exposed in rows were attacked by the insects. . . . . and it was always noted that the moths, when unengaged in laying eggs, were almost always to be found beneath the clods of earth with which the ground was encumbered."† Otto Tepper remarks :—"My opinion is that the eggs are first deposited by the moths upon the stalk near the ground when the infant grub burrows through the soil till reaching the tubers; or the moth itself burrows, as many are found to do, and deposits the eggs direct upon the tubers. My reason for this is the fact that the longer the tubers are left in the soil, the more infected they will prove to be."‡ Boisduval's observations too, though somewhat different as to detail, support this view as to the mode in which the moths finds access to the tuber, whilst the latter is still beneath the surface of the ground.

What is the nature of the operations which take place beneath the surface of the ground may be concluded from what was noticed in our

* We, however, bred a specimen of the insect from a potato *leaf* sent by Mr. G. Searle. This the caterpillar had folded up.

† "Papers and Proceedings of the Royal Society of Van Diemen's Land," 1855, p. 78-9.

‡ "Trans. Roy. Soc. of S. Australia, p. 60. Adelaide 1882.

breeding apparatus. The moths had no partiality for perfectly sound tubers, but would attack those which had previously afforded sustenance to a generation of their kind. In a sound potato the eggs were laid several side by side in contiguity to an "eye" of the tuber; in a diseased one, on the earth-covered surface of a cocoon, within the hole previously excavated by a caterpillar which had emerged for the purpose of pupating, or amongst the "frass" surrounding the entrance to this cavity. As many as twenty-six eggs, laid by a single moth, were in one instance counted in the same location. The eggs hatch in a week or ten days, and often more quickly. The young caterpillars immediately proceed to burrow into the tuber, at first concealing themselves beneath numerous particles of rejected food material fastened together with web, the number of which particles is being continually increased by similar matter brought to the surface. The channel thus formed is also lined with web, so that when the substance of the tuber is broken down these burrowings appear as hollow tubular bodies. The caterpillars arrive at their full size in from two to three weeks,* and then find their way to the surface of the potato, and burrow outwards through the skin. They then spin a cocoon either within the hole thus formed or, more generally, on the surface of the tuber adjacent to it, or, as is often the case, on the sides of the receptacle containing this amongst other outlets, and then immediately transform into the chrysalis phase. Two or three chryslids may be placed side by side. They are always completely covered by particles of "frass" or earth. The fully matured insect—the moth—emerges from the chrysalis shortly after two weeks have elapsed. The union of the sexes almost immediately takes place, and another generation of potato-destroyers arises. The moth is quite a night-flying insect, and only lives a few days.

The number of caterpillars which a single potato may support is very large, and limited only by the amount of food which it yields. Meyrick mentions that one tuber must have contained quite forty larvæ, and we have bred fifty-eight from eight potatoes. "Their voracity, however, is so great, and their diligence in their vocation so untiring, that a couple of individuals will thoroughly riddle and destroy a potato of fair size during their brief but mischievous career." (*Berthon.*) They continue to feed in the tuber when even this becomes completely rotten, and in confinement "deposit their eggs on potatoes when these have become not only putrid but externally shrivelled up lumps, whence fresh larvæ are constantly being hatched." (*Tepper.*)

When potatoes are attacked they soon manifest little heaps of earthy substance on their surface—which conceal the chryslids of the insects or the entrances to the galleries which section of the tubers discovers. This penetrating their substance causes potatoes affected, to rot and become worthless. We do not know how soon the potatoes are first attacked, but if prior to the culms being dry, as is highly probable, those too will no doubt evince well marked symptoms.

Extent of Ravages of Moth.—According to Boisduval, as quoted by Meyrick, in certain districts of Algiers during a single season three-fourths of the potato crop was destroyed by this pest. Otto Tepper thus relates his Adelaide experiences:—"As far as my

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* Tepper makes the minimum to be forty-five days.

continued observation goes the insect causes now (*i.e.*, in 1881), in its immature form of the caterpillar or grub, the destruction of hundreds of tons of potatoes every year by boring them, and thereby inducing putridity. During late years I have scarcely ever been able to get half-a-dozen pounds without finding a considerable percentage more or less affected in this way." Again, "That these moths occur in other situations less confined than the entomologist's hatching case was gleaned latterly from the information a farmer gave me when speaking about the subject. He said he had several bags of potatoes of his own production, and quite healthy when dug, placed in his storeroom, where they were left undisturbed for a considerable time. When he at last came to open a bag for use, lo! quite a swarm of little moths greeted the event, and to his surprise he found the tubers spoiled by the grubs to a great extent."

Prognosis.—With reference to the probability of its numbers increasing in Adelaide, as had been the case previous to the time when his remarks were made, the last mentioned authority on the subject states:—"Unless proper means are adopted to check this growing evil, the chances are that potato cultivation will suffer so much as to become unremunerative, and therefore more and more restricted in area." Meyrick remarks, "under favourable circumstances it may become an almost fatal pest to potato growers;" and again "the species only requires favourable circumstances to become as dangerous economically as the Colorado beetle itself."

Remedies.—These must necessarily be of a preventive character. First, we must endeavour to secure the safety of those in the ground; secondly, we must pay attention to those which are already removed from it. With reference to the first, with our present limited knowledge, we can only endorse the conclusions arrived at by the earliest writer on the ravages of this insect—viz., (1) "That the best soil to sow potatoes in, supposing that the sole object were to exempt them from the grub, would be that which is impervious to the moth—such, for instance, as sand, or a compact loam; and (2) That if no such soil be available, the deeper the potatoes are sown the safer they will be from the inroads of the moth." To protect those potatoes which are already dug up—(1) Separate them at once from any tubers which manifest symptoms of the presence of the pest and destroy these latter; (2) When there is reason to apprehend the presence of the insect, house the sound potatoes immediately; (3) Take such precautions in storing the potatoes as is insisted on, in the following recommendation: let them be "stored in store-rooms without large cracks in floor and walls, or strewn litter of any sort, for in and amongst these the chrysalis state is often passed. If such a store is wanting, deal boxes or tin cases would do as well for smaller quantities, instead of bags. While in store they ought to be frequently stirred; and the walls, etc., carefully swept, as by these operations the chrysalis cases would be disturbed and the insects destroyed." (*Tepper.*) The same writer suggests also that the tubers prior to storing, should be washed clean and bathed in some solution which might be distasteful to the moths or their progeny. He mentions the use of weak salt or sulphuric acid solution, and we would suggest that of alum.

Native Country.—The native country of the insect is not known: it has been supposed that a native moth, the natural food of which is some plant allied to the potato, has developed a decided taste for this esculent.

Distribution.—The means by which such a pest is distributed from one country or district to another are too obvious to need a particular reference to them : "Anyone who will be at the trouble of carefully inspecting a basket or sack in which infected potatoes have been for some time will find a lot of little earthy-looking excrescences adhering to the inside. These are the cocoons of the chrysalides covered with and concealed by earthly matter. They are the media through which the evil is spread throughout the country, and conveyed from one country to another; and they are the pests in embryo, of which every-one ought to try and make a clean sweep." (*H. Berthon.*)

Beetles.

(1) The 33-Spotted Lady Bird (*Epilachna multipunctata,* Muls.).

In March, 1886, we exhibited this insect at a meeting of the "Royal Society of Queensland," and stated that it was generally found feeding on the naturalised Solanum nigrum, or Black Nightshade, but that it also affected the tomato, the potato, and other solanaceous plants. In reference to this exhibit we pointed out that it was a character of the Coccinellidæ, of which Epilachna was a member, to occur at times in immense swarms, and that in the event of such an occurrence, here, in the case of this beetle, potato-growers in Queensland would be great losers. On the same occasion, Mr. G. Watkins remarked too that these expectations had been already in great measure realised, and that this beetle had lately done much damage to potato-growers residing in the Moreton District, and at Laidley Creek had quite destroyed the haulms. We have also learnt that it has done extensive damage in the vicinity of Bundaberg.

The Epilachna is common enough at Toowoomba, but the season of our visit was not such as to bring the destructive habits, to which now we allude, before our notice.

This insect is equally pernicious in its full grown as in its larval condition. In the former it may be observed feeding indifferently on both surfaces of a leaf, scooping away its substance in little parallel tracts, leaving only the epidermis of the side opposite to that on which it is feeding, intact. The paired three-toothed claws with which each foot is armed, enable it to keep its position while so engaged, however much the leaf is inclined or agitated by the wind. The larva, so different in appearance, with its bristle-bearing spines on each segment, is equally voracious. The following description of the insect in its different stages will serve to distinguish it :—

The Beetle is ovate in outline—the head being at the broader extremity, and almost hemispherical in shape, the under surface being nearly flat. The head has yellow antennæ, terminating in brown-clubbed extremities, and is sunk in the thorax or succeeding segment, the rounded projections of which extend on either side beyond the conspicuous black eyes. The insect is clothed with very short depressed greyish hairs. Beneath, the head is light orange yellow, and the remaining portions of the body, with the exception of a blotch on the mesothorax, which is brown, brownish yellow. The upper surface is orange, with black spots. The thorax has a faint mesial impression, and is seven-spotted, having two mesial contiguous spots, one small also mesial spot behind these, and two spots on either side. The

elytra are twenty-six spotted, each wing case having thirteen spots. The spots on them are arranged as follows:—A transverse anterior row of four rounded ones, behind a curved row of eight, the two central of which are square-shaped; behind this row a single spot on each lateral margin; then a row of six spots, then one of two, and behind this two spots, one being at the tip of either elytron. The legs are yellow-brown. Length of body, 5·5 to 7 mm.; greatest breadth, 5 to 6 mm.

The eggs are lemon-yellow, long and oval. They are laid in little patches, each egg being placed erect, and several eggs side by side. These patches which are of different size are found either on the under surface of the leaf of the potato, or here and there on the stems.

The Pupæ.—These somewhat resemble the full-grown insect, except that the elytra and wings are quite rudimentary. Each pupa is contained within what may be termed a false chrysalis, composed of the skin of the larva. This false chrysalis measures $\frac{1}{4}$ inch in length, it is shining brown and has the anterior two-thirds clothed with erect brown hairs. The bristle-bearing spines of the larva are now crowded together and form a rosette on the posterior third of the body. Each spine of the rosette is brown, and the bristles themselves are white.

Life History, Habits, &c.—Our observations have not yet been carried to the extent of determining the time which elapses from the egg being deposited to its being hatched, neither do we know the duration of the larval or pupa states, nor of the life of the adult beetle. The number of generations during a season is also still to be ascertained. When the larvæ are about to transform into pupæ it often happens that they congregate in considerable numbers, side by side, around a thick stem of the plant on which they are feeding, or on that of some neighbouring plant, and, having fastened themselves—by means of a viscid secretion which issues from the last abdominal segment—in this position, undergo their metamorphosis. We have counted upwards of 150 of the pupæ contained in one of the groups thus formed. At other times they occur here and there on different parts of the plants, singly or in twos or threes. The beetles themselves are easily dislodged from the plants on which they occur by shaking the latter. On falling to the ground they draw their legs in, and so for protection simulate death. When further disturbed, whilst in this position, or when handled, they emit from their bodies an acrid yellow fluid. On the mere approach of an enemy, however, they do not at once drop, but, having drawn their legs under them, cling all the closer to the leaf on which they happen at the time to be.

Natural Enemies.—It is very doubtful whether the Epilachna in any of its stages is eaten by birds. When in the larval, as well as when in the pupa condition, the bristle-bearing spines would, we think, serve to repel the ordinary foes of insects. The acrid fluid excreted by the adult insects is too, doubtless, distasteful. These may be reasons to account for the fact that we have never noticed birds engaged in keeping down this pest.

We are, however, greatly assisted in this respect by other insects. The caterpillar, of a minute feather-winged moth, lives and spins its

web amongst their pupæ, and, doubtless, feeds on them in some way which we have not yet discovered. Again, it sometimes happens that the larva is pierced by a minute hymenopterous insect, which inserts a single egg into each of those which it has thus attacked. The grub which hatches from this egg feeds on the larva itself, and, though it does not prevent it from assuming the chrysalis condition, it destroys it prior to its undergoing further changes. We once noticed the characteristic holes in quite 75 per cent. of the pupa cases which we have examined, which bespoke the emergence of the adult fly after, in its earlier stage, it had done its useful work.

Remedy.—On this subject we cannot do better than quote the experience of Mr. J. Philp, of Gatton, who is well acquainted with the damage done to the potato crop by this pest. He writes as follows :—

"I have been asked by several persons if there was no cure for this, and could nothing be done. I have tried kerosene emulsion, carbolic emulsion, and gone with men up the potato rows and shook the bugs off with a small stick on to the wet ground, and squashed them into it with the feet. I have heard of one enterprising individual who got fryingpans, shook the bugs into them, carried them to the headlands, where he had fires, and fried or frizzled them; but, notwithstanding all this, a few hours after each potato stalk had from one to seven or eight bugs upon it. The reason is simply this. The bug is a winged insect, and feeds on many indigenous plants or weeds, and no sooner do we kill them on the potatoes than there are thousands all round ready to take their place. The only cure I see for this is clean cultivation—allow no weeds to grow on the headlands, and, if possible, keep a hand's breadth of ploughed ground all round the potato crop. The bug, although it has wings, cannot fly far, and must alight on something above ground to give it a rise before taking flight."*

Their attacks, however, might probably be prevented by poisoning the leaves on which they feed, in a similar manner to that adopted in coping with the Colorado beetle. For this purpose *Paris* or *Scheele's Green* (arsenite of copper) should be used. This is employed dry or in the wet state, and variously diluted. The following directions are given (1) in using it dry :—Mix one part with from 25 to 100 parts of ashes, plaster, or flour—preferably the latter, as affording a more adhesive substance. (2) If employed wet, mix 1lb. of the green with from 40 to 100 gallons of water, adding a little dextrine to ensure adhesion. In this case the mixture will require to be constantly stirred whilst being used. The liquid, of course, will have to be distributed by means of some spraying apparatus. Samples of commercial Scheele's Green (or Paris Green) vary in composition, and the purchaser should therefore endeavour to acquire such ones only as contain a minimum quantity of foreign material. In the United States this chemical is quoted at 60 cents per pound. *London Purple* may profitably take the place of the Scheele's or Paris Green. It is a waste product obtained in the manufacture of aniline dyes, and would require to be specially imported. It is composed of lime, arsenious acid, and carbonaceous matter. It is cheaper than the Paris Green—selling in the United States for 5 cents per lb.; it covers more ground weight for weight; is more adhesive, more soluble. On the other hand, it is not quite so poisonous as the latter chemical.

* *Courier*, Brisbane, 2nd May, 1887.

(2) The 8-Spotted Lady Bird (*Epilachna*, sp.).

This beetle has habits which are closely comparable with those of its ally, the 33-Spotted Lady Bird. We have noticed it at Brisbane feeding upon the leaves of the potato, and, not infrequently, in some numbers. The following description will serve to distinguish it:—

Adult.—Shape ovate, rounded in front, narrowing behind, very convex ; elevated in middle line of back, anterior to the central point, and depressed forwards and backwards; flattened beneath, descending behind, with antero-posterior contour arcuated. Head immersed in the succeeding segment (prothorax). The latter expanded on each side, but not extending outwards to the level of the shoulders of the elytra, rounded lateral angles reaching to the fore-borders of the eyes. Epipleuræ (inwardly directed outer borders of elytra) broad concave, extending the whole length of the elytra. Closely punctuate and clothed with yellowish-grey appressed pubescence ; black, with eight large yellow and red spots disposed as follows—two spots occupying each outer-third of prothorax, and two spots, one on each outer side of wing cover, a short distance behind shoulder, yellow ; two contiguous spots intermediate with the latter yellow spots, and with them forming a transverse series, and two non-contiguous ones on the hinder third of elytra, and, meeting the lateral margins, forming a second transverse series, red ; the latter two margined externally with yellowish ; under surface, with the sides of the abdominal segments, reddish, the remainder black. Labial palps long, yellowish, with large ovate terminal joints, brown ; mandibles black-tipped ; labrum with light anterior spot ; antennæ yellowish-brown ; eyes black ; legs black, with the yellowish grey hairs on the tibiæ longer and thicker than on other joints ; tarsi beneath thickly clothed with short hairs of same colour. Length, 10 mm. ($\frac{5}{12}$ inch) ; greatest breadth, 7·5 mm.

The Larva.—Body of uniform breadth, swollen, slightly tapered towards each blunt extremity ; armed with numerous erect bristle-bearing spines disposed as follows—viz., four on segment next to the head, and also on eleventh segment, directed backwards and forwards respectively, and six on each of the intermediate segments. These spines are arranged in six rows along the sides of the body, two infero-lateral, two supero-lateral, and two dorsal. On the third and fourth body segments the dorsal spines are approximated to the supero-lateral ones of those segments. Each spine bears from ten to fifteen often black-tipped spinelets. At its immediate origin the body displays its ordinary ground colour, but beyond there is an almost black encircling band—ocellated rectangular spots being thus produced—the spots of the dorsal spines are contiguous along their inner edges. Mandibles brown, black-tipped; eyes black; vertex above each eye brown; legs brownish, becoming black towards their extremities. A few white hairs on face, and others clothing legs ; about six rosettes of pale short light-coloured hairs in the centre of each segment beneath, remainder of body glabrous and glistening. General colour light-yellow, uniform beneath, above varied by the black ocellated spots and spines.

Pupa.—This is usually placed on the under surface of the leaf on which the larva has been feeding, and it almost invariably happens that the part corresponding to the head of the insect is directed away from the base of the leaf. There may be several pupæ on one leaf. It is oblong in shape, rounded at each end; in form it is swollen being

regularly convex from before backward and from side to side. The bristle-bearing spines are now crowded to one end, where they form a rosette occupying about one-third of the whole pupa, but extending more anteriorly above. Anterior portion of pupa glossy, dark brown, lighter brown at the union of component parts, covered with erect short brown bristles, especially numerous at the sides and in front, but fewer on the part corresponding to the dorsum of the abdominal segments. The four abdominal segments exposed have each a white spiracular tube on either side. The bristle-bearing spines are now black, the bristles themselves being white with black tips. Length 8 mm. (0·312 in.) x 5·5 mm. (0·2 in.), becoming longer by being drawn out as the adult beetle emerges.

NOTE.—Both the above insects occur from Cape York to the Southern border of the Colony.

GREEN POTATO BUG (*Cuspicona virescens*, Dal.).

This is a small grass-green plant-bug belonging to the family Pentatomidæ, measuring $\frac{7}{20}$ inch in length, and rather more than $\frac{1}{5}$ inch in greatest breadth. It has a broad but sharp tooth on each side of the body, and in front of the teeth is triangular in shape, the head being obtuse. This anterior portion inclines abruptly downwards. The five-jointed proboscis rests on a keel between the bases of the limbs, and extends as far as the hind pair. On being molested it discharges an acrid fluid having a very penetrating odour. The following is a technical description of the insect:—

Adult.—Grass green, rather paler beneath, oval, minutely punctured. Head rounded in front, lobes of nearly equal length, side lobes obliquely reticulate-punctate, ocelli and eyes dark brown, the latter becoming nearly black after death. Rostrum black-tipped, extending beyond first ventral segment. Antennæ pale brown, first joint not extending to front of head; second, fourth, and fifth sub-equal, third shorter. Thorax with a transverse smooth space on each side in front; hind angles obtusely pointed, the extreme tips being blackish. Pectoral keel well developed, posteriorly receiving the short ventral spine in a groove. Scutellum broadly triangular, obtuse, excavated on each side, extending to the hind border of the ante-penultimate abdominal segment. Legs light green, tarsal joints light brown, tibiæ and tarsi hairy. Abdomen broadly lanceolate, having a low broad central ridge continuous with the ventral spine; the posterior lateral angle of each segment ending in a small black tooth. Membrane of fore wings colourless. Length of body 9 mm. ($4\frac{1}{2}$ lines).

Egg.—The egg is an oblong body rounded at each end, of a milky-white colour with glossy lustre.

Larva.—This is generally like the adult, except that it is usually darker in colour and has numerous fine points of a brown hue. There are also brown blotches along the centre of the back of the abdomen. It has no wings. At first the thorax is brownish-black, owing to the approximation in this situation of the wing-covers. When the body is about $\frac{1}{5}$ inch in length, the dark colour on the thorax has already disappeared, but the blotches on the abdomen, though less pronounced, are still present; the antennæ at this period are white-and-black tipped. Shortly after this, the wing-covers commence to grow

backwards. The general colour of the body from being of a darker green, now becomes of a lighter hue, but afterwards regains much of its intensity of colour.

Habits.—The eggs are laid singly on the under surfaces of the leaves. There are numerous broods throughout the summer, and the insects may be found on the plant in all stages of growth at the same time, and frequently several on the same leaf. They feed by inserting their rostra or probosces into the tissue of the leaf, and thereupon imbibing its juices.

Nature of Injury.—The effect of their puncture is often that of killing the tissue of the portion of the leaf operated upon, but this is not invariably the case. When in great numbers they may do considerable damage, especially when they attack early potatoes.

Occurrence.—The first notice of their habit of injuring, or even feeding on the potato, was received from Mr. Searle, of Rosehill Gardens, Toowoomba. This Cuspicona is, however, a native insect, and we have long been familiar with it, as a common pest of another solanaceous plant—the ordinary "blackberry" of school children, the nightshade (*Solanum nigrum*). So that on having discovered the natural affinity between the two plants, it has migrated from this weed on to the potato, thus repeating the action taken by both the preceding beetle pests.

Remedies.—At present the extent of its ravages is not such as to call for the use of special means for preventing its attacks.

FUNGUS DISEASES.

False Potato Disease (*Epicoccum scabrum*).

Our object in the following remarks is to correct an impression that has gained ground concerning the appearance in the colony of the well-known fatal potato disease (*Peronospora infestans*). This has emanated from one whose statements concerning the potato are received with favour, seeing that he is an author of a work on the subject. In the *Queenslander*, 9th October, p. 591, it is stated that "Mr. James Pink, writing from Wellington Point, under date 1st October, says, 'I enclose a portion of potato haulm destroyed by *Peronospora infestans*, better known in Europe as the potato disease, which I regret to say has made its first appearance in the district. This is not the first time I have seen it in the colony, but this season is favourable to its development.'" The part of the potato plant forwarded by Mr. Pink in illustration of his statement is thus referred to by the agricultural editor of the same journal: "The portions of haulm sent show the usual withered appearance common to fungus-destroyed vegetation, and similar to that described as the appearance of haulms destroyed by 'the potato disease' in Europe, now known to be produced by the ravages of the fungus Peronospora infestans."

These identical specimens, as representative of the diseased condition attributed to the attacks of the potato fungus, were then forwarded by Mr. F. M. Bailey to the eminent specialist the Rev. M. J. Berkeley, and at the decease of the latter found their way into the hands of the equally celebrated authority, C. M. Cooke. Now, the latter specialist failed to discover the presence of the Peronospora, but found instead another fungus which had been mistaken for it—*i.e.*,

Epicoccum scabrum of Corda, a fungus belonging to an entirely different order, and common, in both Europe and America, upon a number of different herbs, being found on the putrid stems of several Compositæ and Umbelliferæ, on the stems and glumes of grasses, and on the roots of coniferous and other allied plants.*

Not having seen these plants when affected by Epicoccum scabrum ourselves, we are unable to describe the characteristic form of diseased condition in the potato which it accompanies. It is interesting, however, to learn, also from the *Queenslander*, that "the disease, as shown in Mr. Pink's garden, is upon a row of Manhattan potatoes, the produce of some extra seed . . . procured . . . from a well-known grower in the Allora district.

SWEET POTATO.

Sweet-Potato Weevil (*Cylas formicarius*, Olivier).

This very destructive pest has been brought to our notice as occurring in the East Moreton district. Like the "grub" of the common potato, it will no doubt shortly occur further afield. As, however, the adult insect is wingless, the distribution of the pest almost entirely depends on human agency. But, insomuch as it has been introduced by such means here, the chances of its range of occurrence being still further extended are not altogether remote ones.

Symptoms.—The skins of the tubers are penetrated by numerous small punctures about one-sixteenth of an inch in diameter, and by fewer large ones. Of these punctures the smaller ones are either carried only a short distance below the surface of the tubers, or are continued, as is the case with the larger ones, into their substances. These borings intersect the tissue of the potatoes in all directions; and when—as frequently happens—they are made just beneath the surface, they lead to the presence of meandering tracts of dead tissue upon it. They are found to be tenanted by white grubs, measuring about a quarter of an inch in length; by the white nymphs of weevil larvæ in small cocoons made of potato *débris*; and often, also, by the adult weevils themselves. At other times the tunnelings are discovered to be completely filled with the food dejecta of the above larvæ, and amongst this *débris* and feeding upon it, small mites may also be commonly met with.

Cause.—The beetle which occasions this is an oblong narrow weevil, measuring, when extended, about one quarter of an inch in length, with rather prominent forwardly-directed snout, and with the three divisions of the body—*i.e.*, the head, thorax, and abdomen—well defined, both as regards form and colour; the head being black, the thorax red, and the hind body steel-blue. The last is also narrowed both before and behind, and is very deep and convex.

These weevils pierce the skins of the sweet potatoes by means of their well-developed snouts, and then deposit their eggs in such of the cavities thus obtained as they may select for the purpose. These hatch, and the resulting larvæ or grubs feed their way into the substance of the tubers. Thus the smaller holes and tunnelings leading from them are accounted for. The larvæ continue to feed within the

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* *Cf.* P. A. Saccardo. "Sylloge Fungorum." Vol. iv., Hyphomycetes, fol. 51, p. 739. Batavia, 1886.

sweet potatoes until they are full grown, and they then undergo, within it, all the changes intervening between the grub and the adult beetle condition. The beetles make the larger holes and emerge through them to repeat the same work of destruction which the continuance of their kind involves.

The adult beetle presents the following characters :—

The Beetle.—Smooth, glossy; abdomen both above and below steel-blue; prothorax, except anterior border, mesothorax and limbs red; femoral enlargements and tarsi inclining to brown; head, fore-border of prothorax, and funicle of antennæ black. Prothorax and abdomen above and beneath with microscopic sub-remote punctures, each giving rise to a minute greyish hair. Head and rostrum more coarsely and closely punctured, especially the latter, which is also corrugated at the sides. Head narrowed behind the eyes, and with a few fine transverse lines in this region. Rostrum stout, very slightly arched, elongated. Eyes large and prominent; antennæ, with the scape, very short; the funicle 8-jointed, with the 6th and 7th joints larger and longer than the rest—which are sub-equal; mass 1-jointed, cylindrical, exceeding remainder of antenna, and clothed with grey hairs; prothorax elongated, truncated at both ends, divided into two convex parts—the hinder of which is the shorter—by a deep encircling groove; abdomen narrowed in front and behind, compressed from side to side, first and second segments beneath soldered together. Elytra narrowed, deep and very convex, covering and closely embracing the abdomen. Scutellum absent, wings absent, legs rather long, especially hind pair, which exceed the abdomen; femora longly pedunculated and thickened distally; tarsi elongated. Extreme length, 6 mm. (3 lines).

This insect accords with the description and figure given by Comstock* for a small beetle which has been observed in the United States to be there destructive also to the tubers of the Sweet Potato. This insect Comstock refers to *Cylas formicarius* (Olivier), the type of which beetle was derived from the Mauritius. If, however, Olivier's Cylas is the *Brenta formicarius* (Fabr.), as seems probable, this determination will require revision, for the latter insect, according to Lacordaire, belongs to the section of Cylas, which is characterised by the possession of "un livrée uniforme," and not to that which includes parti-coloured insects.

No species of *Cylas* has been hitherto recorded as occurring in Australia, but the tribe *Cylades* to which it belongs is represented by two species of *Myrmacicelus*, one of which is a very common insect.

There can be but little doubt that this pest, like many others, is an importation. At present we only know of its occurrence in the East Moreton district of the colony; but insomuch as it can be, and is, distributed in the tubers themselves just as the trade in this description of produce is prosecuted, this alone forms sufficient justification for the inclusion of a note on the subject in this Report.

Remedies.—We would suggest that the potatoes be unearthed as soon as demand for them has arisen, and consumed with as little delay as possible; all the affected ones being destroyed or used as food for stock. Also, if practicable, in a district where the disease has manifested itself, all the sweet potatoes which have been raised there be consumed on the spot, and that during the succeeding season no sweet potatoes be grown.

NOTE.—There are other enemies to the Sweet Potato. These we do not feel called upon to treat of on the present occasion.

* *Rep. Depart. Agric.*, Washington, 1879, pp. 249 and 250, pl. VI., fig. x.

CHAPTER IX.

Cereals.

MAIZE.

INSECT DISEASES.

Corn Worm No. 1 (*Heliothis peltigera*, Engr.).*

The maize throughout southern Queensland is very subject to the presence of the destructive caterpillar of this notorious moth, and its ravages may be discovered in almost every cultivation.

Symptoms.—The maize when attacked by this Heliothis "worm" may present different appearances. When the cob is the seat of injury we may find the tassel or topmost grains quite eaten away, and an excavation made into the central pith. At other times the sheathing bracts or husk are more or less consumed, or holes are gnawed through them to the surface of the grains, which may be eaten in patches, or along certain meandering lines indicative of the direction of the passage of the caterpillar. When this happens the place of the consumed grains is often occupied by rejected matter which moulds and sometimes determines the presence of mildew throughout the cob. Oftentimes, again, the caterpillar has chosen the maize stalk for its sustenance, when, by reason of the presence of tunnelings into the more interior parts of the plant, it happens that the corn stalk with its cob becomes wilted or may even get broken off.

This injury is occasioned by a greenish, yellow or red spotted, and black speckled caterpillar, which in course of time develops into an active, quick flying moth. The latter, when disturbed, has the habit of darting rapidly off to a spot but a short distance away, where it alights with its wings directed backwards.

The following are descriptions of this pest at different stages in its life history :—

Caterpillar.—Cylindrical with the 11th segment humped, labrum emarginate. General colour pale green above and below, with light brown head ; hairs on body white. A few scattered hairs arising from conspicuous jet-black spots. First body segment marbled black and white, remaining segments longitudinally striped, with fine irregular waved white markings. These markings on the infero-lateral portions of the segments forming two continuous white lines, one bordering the margin of the dorsal surface, the other just above the stigmata. Two dark-grey, almost contiguous centro-dorsal lines. A dark-grey band along the middle portion of each side, with black blotches touching it above on segments four to eleven inclusively. Yellow spots included in the lateral bands, on second to tenth segment, one for each segment.

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* This insect is so named as corresponding to Hubner's figure of *H. peltigera* (in *Eur. Schmett. Noctuæ, pl.* 63, *fig.* 300) more nearly than it does to his representation of *H. armigera* (*Op. cit., pl.* 79, *f.* 370). However, it may eventually be discovered that both are races of one species, a conclusion at which Lieut-Col. C. Swinhoe seems to have arrived (vid. P.Z.S., 1884, p. 518). The species of Heliothis are very liable to variation. *Heliothis rubescens*, Walker, also occurs about Brisbane, and may, too, be only another form of *H. armigera*. The plate illustrating the Corn Worm in the Fourth Report of the United States Entomological Commission gives representations of the *peltigera* and *armigera* races, whilst nominally illustrating a single insect with the latter designation.

Stigmata black. Piliferous spots, slightly raised, jet black, and arranged as follows:—One spot above the stigma on the first segment, two within the yellow spot of the second and third; one below and two within the black blotch of the fourth, the tenth, and the eleventh segments; two above and two below; forming a rhomb, from the fifth to ninth segments inclusively. Head marbled with white, mandibles tipped with black. Length, $1\frac{1}{4}$ inch; breadth, $\frac{3}{16}$ inch.

Chrysalis.—The chrysalis is dark-brown; the abdominal segments are laterally punctated anteriorly; the last segment is somewhat elongated, and is terminated by two straight almost contiguous spines, one of which is longer than the other. Length, 17 mm. ($\frac{7}{10}$ inch).

Moth.—Wings moderately broad, straight in front, apex rounded, external margin oblique, posterior slightly recurved. Thorax above light-fawn coloured; abdomen whitish at base, light brown beyond. Forewings light fawn-coloured; orbicular spot indistinct light brown with dark centre; reniform spot similar but more distinct; a few light brown oblique marks on the costal edge; two very indistinct light brown lines obliquely upwards from posterior border at base to orbicular spot, another to reniform spot; outer and marginal waved lines similarly light brown, space included by them pink internally and light purplish gray externally forming a fascia across the disc with small black points on the veins, outer edge of wing with line of black points—one between each two veins, and fringed with cilia, which are brown at the base and purplish red beyond. Hindwings, paler, semidiaphanous towards base; veins brown, disco-cellular distinctly marked but scarcely forming a brown lunule. A broad marginal blackish band across the disc, reaching to the outer edge, suffused with reddish pink, a blotch of which colour generally occurs contiguous to border in the space included by the median veins: this blotch when not reddish pink is white. *Beneath:* The fore wing has the orbicular and reniform spots black and very distinct; discal band blackish, discontinued at hind median and pinkish-red anterior to fifth subcostal venule. Hind wing with discal band similarly dark-coloured and red-pink anteriorly. Sexes alike, but male the smaller. Expanse of wings, $1\frac{5}{16}$ inch to $1\frac{11}{16}$ inch.

Habits.—The moth which may be observed during the evening quickly vibrating its wings in nervous flight as it hovers over some flower, deposits its eggs singly on the plant. These, according to the degree of development to which the maize has arrived, are placed on different parts of it. Deposited on the young leaf, the caterpillar, when hatched, first gnaws at these and then works its way downwards to the leaf-sheath, and so arrives at the cob, the husk of which it pierces. The young caterplilar may also be born upon the tassel or upon the silk or top of the cob, in which case also it finds its way to the maize kernels. It is exceptional only that it enters the stalk of the maize plant and confines its depredations to this part of the plant. Usually a single caterpillar is found in every cob which shows signs of being damaged by the corn worm, but sometimes there is not one present, the original culprit having moved to another plant. The maize may be attacked at any stage during its growth, and the "worm" may be found even in cobs which are harvested. When fully matured, the caterpillar finds its way to the soil, and beneath this excavates a small elongated cavity, within which it changes to the

chrysalis condition. During the summer months the moth is probably soon hatched from the chrysalis, but the number of broods which occur during the year, in any part of the colony, has not yet been ascertained. We have observed the moth flying at Brisbane during January, February, and May.

It is worthy of remark that the so-called corn worm by no means restricts its attention to maize. We have found it within the pods of peas, and also within green passion fruit, feeding on the seeds of these plants, and also probably—for we have not verified its occurrence under these circumstances by breeding the moth—in the ovaries of quite a number of different plants, including the tomato amongst their number.

Remedies.—When once the caterpillar has attacked the corn little can be done to stay the injury due to its presence. To prevent its subsequent appearance, it is perhaps expedient to remove the means for its subsistence by adopting a rotation in crops which do not afford it food, with those that do. The practice of allowing the maize crop to remain in the field until late in July, although it may to a certain extent secure the corn from the attacks of weevil, is about the best way for ensuring the perpetual presence of the pest now under consideration. We would especially point out that we have discovered that this pest is practically identical with the notorious Boll Worm (*Heliothis armiger*) of the United States, which for several years past has been known to include the maize plant amongst the many others, besides cotton, whose seeds or seed capsules it attacked. In 1881 this pest, as Professor Riley informs us, did excessive injury to the corn in the more northern States, and is otherwise regarded as "one of the most widespread and injurious" which farmers in these regions experienced. It thus happens that anything written concerning the Boll or Cotton Worm is singularly pertinent to this report. We may therefore add that the following form of lamp has been recommended by J. H. Comstock for capturing the Heliothis moths, and has been stated by him to have been used with success in Central Texas in protecting the cotton crops from the pest under consideration:—"The whole apparatus (which is of very simple construction) consists of three pieces; first, a shallow tin pan 15 by 10 inches; second, a common kerosene lamp with a half-inch wick, and large enough to burn all night; third, a common lantern top large enough to place over the lamp and protect it from wind and rain." The following is the method of use:—"The lamp is placed in the middle of the pan and the latter filled with water, on which has been put a small quantity of kerosene. The whole thing is placed upon a post, high enough to be above the top of the crop." With reference to the outlay which this procedure will necessitate, there is first the initial cost of the apparatus, to which must be added that of the kerosene and the labour involved, items whose amount will depend on local circumstances. In America it has been found that "the cost of the lamp is 50 cents (2s. 1d.), and the cost of burning it and labour about 35 cents (1s. 5½d.) per month." In practice the insect is attracted by the light, comes into contact with the lamp and then falls into the kerosene floating on the surface of the water in the pan, and is so destroyed.*

* *C.f.* Report Comm. Agr., U.S.A., 1880, p. 239.

The Corn Worm (*Heliothis armiger*, var. *peltigera*) has a very extended range of occurrence, and is met with not only in America and Australia, but also in Europe, South Africa, Southern Asia, and even in New Zealand. In India, as Surgeon-General Balfour has stated, "it attacks the leaves and capsules of the Poppy and all the various pulses, especially the Mussors (*Ervum lens*), Chana (*Cicer arietinum*), and Murtur (*Pisum sativum*), less frequently Urhur (*Cajanus indicus*), boring into poppy capsules and feeding on the seeds."* It may be interesting to remark that about the first moths of Heliothis armiger reared in Europe, were raised in 1864 by Professor Heer, of Zurich, from caterpillars which he fed on maize.

CORN WORM NO. 2 (*Conogethes punctiferalis*, Guen.).

Injury quite as extensive and of similar nature is often caused by the caterpillar of the small yellow moth—*Conogethes punctiferalis*. (*Vid.* p. 77.)

THE RED-BANDED GALERUCA (*? Luperodes*, sp.).

This is a small oval-shaped pale yellowish-coloured beetle rather more than $\frac{1}{6}$ inch in length, which has a red band across the base and a spot of the same colour in the centre of the wing covers, and a dark-brown central area beneath. The antennæ are long and filiform.

It is not known that it develops any destructive propensities at Toowoomba, or even that it occurs there, though this is highly probable in view of the fact that it is generally distributed along the coast lands from the Southern limit of the colony to the latitude of the Johnstone River.

Nature of Injury.—It has been reported, by Mr. C. J. Wild, that at Nerang, near Southport, this beetle occasionally does considerable damage to the maize by feeding in the grain when this has arrived at that stage when it is about to lose its green colour. As many as twenty beetles may be found within a single cob—though there may be no special outward indication of their presence. They may occasionally gnaw away quite half the grains which it contains.†

The following description may serve to identify the beetle to which these remarks relate:—

Luperodes, sp.—Pale yellow, with a broad band across the anterior portion of the elytra, and a spot about midway between this and the hind extremity of each, sanguineous; metathorax dark-brown, labrum light-brown, mandibles light-brown dark-brown tipped; joints of antennæ from flavous to dark-brown at the extremities; head and body glabrous. Head immersed in prothorax to hind border of orbits, smooth above, with sides behind the eyes coarsely punctured. Clypeus extending back between antennæ in an accuminate point which reaches just beyond hinder border of antennary fossæ. Mandibles four-toothed,

* "In Agricultural Pests of India," London, 1887, p. 68. These remarks are made in reference to H. armiger, but for the varieties under which this insect occurs there, as mentioned by the author, it is evident that they are equally pertinent to the habits of the race *peltigera*, which is also commonly found in India.

† Unfortunately the depredations of the Luperodes are not restricted to the maize plant. In March, 1889, Mr. R. J. Gray intimated that this beetle was destroying everything in his garden. Leaves of rose, mango, and fig, from which all the tissue, except that composing the venation, had been removed, bore out this statement. It has occurred at Brisbane, as Mr. H. Hockings has informed us, upon mangoes, whilst the latter are in flower, quite destroying their blossoms.

with one strong outer-tooth and three smaller ones internal to this, of which the innermost is very small and blunt. Maxillary palps with penultimate joint long obconic, and terminal joint almost as large as long in the form of a rather sharp cone. Labrum shallowly emarginate; eyes coarsely granulated; antennæ slender filiform, springing from between the eyes, the antennary fossæ being opposite the middle of the inner border of the orbital fossæ, and distinct from them. 1st joint, long claviform; 2nd, oblong; 3rd, a little longer; 4th, as long as the first, and longer than second and third united; remaining joints subequal, but rather decreasing in length distally. Prothorax at least twice as broad as long, the anterior border straight, the lateral and posterior rounded. The angles obtuse, the anterior ones swollen, the surface without any transverse groove. Scutellum conspicuous, in the form of an equilateral triangle. Elytra oblong-dilated, and very obtuse behind. Surface regularly convex, and confusedly punctured. Epipleuræ well defined, concave, broad in front, for a short distance of equal breadth, then widened, and then gradually narrower, and vanishing before reaching end of elytra. Presternum reduced to a narrow line between the legs widened out on each side behind to meet the prothoracic epimera. Cotyloidal cavities of 1st pair thus complete behind. Metasternum well developed and very convex, extending forwards to form the inner half of the cotyloidal cavities of the middle pair of legs, the hind border with a central deep cleft forming two contiguous strong blunt teeth. Legs slender, 1st pair short, hind pair about twice the length of these. Tibiæ armed with terminal spurs, those of 1st and 2nd pair very short, that of hind pair long. Posterior tarsi with 1st joint longer than the three following united, the 2nd and 3rd subequal in length. Uncinuli appendiculate and divaricate. Length $2\frac{1}{2}$ lines (5 mm.).

Notwithstanding the fact that this beetle has the anterior acetabulæ complete, it is placed in the group Luperiteæ of the Galerucineæ, since J. S. Baly has shown (Proc. Lin. Soc., Lond., vol. xx., p. 156, Lond., 1888) that the state of the acetabulæ cannot be regarded as a primary character in dividing the Galerucineæ into sections. The species of this group hitherto recorded are from the East Indies, Ceylon, and India. Although the antennæ are somewhat different, the insect under examination resembles a Luperodes.

Habits.—This beetle, whilst in the larval condition, lives beneath the surface of the soil. When adult it runs over herbage with considerable activity, and readily takes flight.

Treatment.—It is difficult, with our present limited knowledge, to suggest any remedy.

LEAF-HOPPER (Fam. *Fulgoridæ*, *Delphax*, sp.).

This insect is a small leaf-hopper, measuring rather less than $\frac{1}{6}$ in. in length, which has membranous well-developed wings. When mature it is exceedingly active in its habits, springing with suddenness from its resting place on the least disturbance. Usually several individuals of different ages occur congregated at one spot. Its sustenance is derived from the sap of the plant on which it is met with, and this it procures through the agency of a somewhat efficient proboscis.

Attention was first directed to this insect as possibly injuring the maize plant by Dr. J. Bancroft. The latter submitted examples, presumedly derived from the Moreton district; but furnished no information concerning the nature of the injury which they occasioned, except that implied in the statement that they were found upon growing maize. They have also been quite recently forwarded by Mr. A. Alexander, of Ingham, from the Herbert River District. The *Delphax* is common in pastures about Brisbane, and especially in sheltered spots where the grass grows rankly. It is by no means confined to maize, but may be met with on the naturalized *Bromus unioloides*, on *Cynodon dactylon*, and upon many other grasses.

The following description will serve to identify the species :—

The Adult.—A small insect measuring less than 2 lines (3·5 mm.) in extreme length, with the wings, which expand to rather more than 3 lines (6·5 mm.), deflexed—with the anterior borders downwards, and directed backwards during repose. The face is bent obliquely under opposite the eyes, and is continued into a blunt proboscis which extends just beyond the middle pair of legs. The vertex of the head is occupied by a small rectangular depressed area, from the ends of the fore-border of which arise two keels, which unite to form a single mesial longitudinal keel which traverses the centre of the front of the clypeus and hind part of rostrum. From the same point also arise two other similar keels, which, following the inner borders of the eyes, run parallel to the former, and form the lateral boundaries of the compressed face, which is thus tricarinate. Two other keels arise, one from each inner fore-border of the eye, and meet the lateral ones on the first joint of the proboscis. The keels are white-coloured bounded with dark-brown and have yellowish interspaces. The eyes are very large and are emarginate in front; they extend to the upper surface and hind border of the head. A small dark-coloured ocellus is situated opposite the fore-border of the eye within the lateral frontal ridge. The antennæ arise within the emargination in the fore-border of the eyes. They are three-jointed, with a terminal setiform jointed flagellum. Both the first and second joints are very much enlarged, but the third joint is narrow and very small. The first joint is cylindrical and slightly enlarged distally; the second joint is nearly twice as long as the first, and has its distal end swollen and rounded. It bears circlets of very short, dark-brown bristles. The rostrum is three-jointed, stout, and dark-tipped; it extends just beyond the middle coxæ. The prothorax is not quite so broad as the head—including the eyes; it is rounded in front, excavated behind, and light-yellow coloured, with three slightly raised and divergent light stripes. The meso-thorax is rounded in front, and produced into rather a long obtuse angle behind. It has more pronounced—but otherwise similar—light bands to those on the prothorax, and its fore-border is sometimes dark-coloured. The abdomen, in which seven joints may be counted, is black, with orange-yellow between the segments. The wings are as in other species of the genus *Delphax*, and, in repose, extend about ½-line beyond the abdomen. The forewings are elongate, with almost straight fore-borders, rounded outer-borders, and slightly excavated hind-borders. They are clear and suffused behind with a slight yellowish-brown tinge. The veins are brown, but those of the outer half much darker brown than are those of the inner half. They give rise at the site of rather distant tuberosities to short nearly black setæ, which are very conspicuous on the inner halves of the wings. The hind wings are milky pellucid, broadly triangular, with two slight emarginations along their oblique exterior borders. Their veins are glabrous. The hind legs are by far the longest; their tibial and first and second tarsal joints have black terminal teeth; the tibia is terminated, in addition, by a large finely dentate semi-elliptical plate. The first and second joints of the tarsi of the fore pair of limbs have each a small pulvillus.

Larva.—When first hatched the young insect is not quite half a line in length, and has little or no indication of wings. Its eyes at this time are pink, and, therefore, conspicuous. At a later stage, when both pair of wings are represented by rudimentary organs, which are widely separate on the upper surface of the body, the insect is light-brown, with the pale stripes of the thorax rather broad and continued to the extremity of the abdomen. When older, fully developed wings are acquired. The skin is molted several times as the larva continues to grow.

Habits.—The eggs are laid beneath the epidermis of the leaf-sheath of the maize or grass. On this may be noticed very small low elevations. Usually there are several—four or more—of these in a linear series, and there may be many series on a leaf-sheath. These swellings have a narrow orifice or small slit on one side. In this the eggs have been deposited, and through it the newly-hatched larvæ emerge. More than one egg is placed in each slit. As soon as born the young larvæ may be observed on the maize or other grass just above the joint or node, with their probosces applied to the surface of the plant tissue. This proboscis is canaliculate, and through it pass the mouth organs—four slender hairs. The latter are probably inserted into the stomata of the plants, and so the sap is imbibed. The rostrum or proboscis, though narrow, is a somewhat blunt organ, and not itself adapted for piercing tissue. All the life of the insect is passed upon the plant which sustains it. When maize fails, native grasses afford it food, but whether or not it hibernates during the winter months, and, if so, in what condition has not been ascertained. When disturbed it makes prodigious leaps, aided in so doing by the curious tibial plates of the hind legs above alluded to. It has not been recorded of any species of *Delphax*, nor indeed of any insect belonging to the family *Fulgoridæ*, that it is destructive to economic plants.

Nature of Injury.—Associated with the presence of these insects there has been observed an affection which has much in common with the "Maize Disease" proper (p. 205). Mr. A. Alexander, of Ingham, writes:—"Before the green plants show any sign of disease, except a lighter hue in the centre, one may notice scores of young insects (identical with those described in this article, H. T.), the size of mosquitoes, jumping about the centre of the stalk, after a while the latter will commence to wither, and on pulling the maize-plant asunder one will perceive large numbers of larvæ, the progeny of these insects." The "disease" which Mr. Alexander mentions, as far as may be concluded from exhibits he forwards, presents the following characters:—Upon the leaves, just beyond their origin from the leaf-sheaths, there arise spots, blotches, and patches, measuring from one line to four or more inches in greatest diameter, in which the green colour has become discharged, and is replaced by a uniform brownish-white. These affected areas are usually elongated in the direction of the growth of the leaf, and their limits are marked by faint narrow curved brown lines. The tissue involved in these spots, blotches, or patches ultimately dies. The leaf-sheaths exhibit similar phenomena towards their free borders. These symptoms are at times sufficiently pronounced to lead to the destruction of a great portion of the maize-crop. During the season 1888-9, when "the enemy cropped up," Mr. Alexander lost 75 per cent. of his maize from this disease, and his neighbours, at Ingham, also suffered in consequence of its presence.

To a portion of diseased maize-plant forwarded by Mr. Alexander were still adherent, though dried up, a few specimens of the leaf-hopper we have described in different stages of development, and it might be concluded from this that these insects give rise to all the symptoms of disease recorded, and especially so seeing that they are both competent to and do injure the maize-plant. We are not, however, prepared to admit as much concerning them, but only that they may act as the exciting cause of the Maize Disease—which we are of opinion is immediately due to another cause. The same insects may be observed, as we have remarked, infesting quite a number of grasses besides the maize-plant, but do not on them occasion any injury comparable with the disease before us; and, again, a maize disease very similar to that one, the symptoms of which we have described, may be met with when the leaf-hoppers are entirely absent from the crop.

Maize Aphis.

We observed that the Maize at Toowoomba was in many instances very much infested by aphides.

These well-known pests insinuate themselves between the young leaves of the shoots, or crowd on the inner surface of the bracts as the latter still enclose the ripening cob. In both cases they impair the development of important vegetative organs. On the shoots opening out, their component leaves present, usually, a characteristic crumpled or corrugated appearance, as a result of the injuries inflicted by this pest.

The Aphis itself we have not yet examined, but it is probably one or other of the species already known as affecting maize in other countries. Amongst these are: Pemphigius boyeri, *Pass.*, and Pemphigius zeæ-maidis, *L.* and *D.*, in Europe; and Aphis maidis, *Fitch*, in America.

It is satisfactory to have to record that at Toowoomba the Maize Aphis is extensively preyed upon by a Lady Bird, by the larva of a Chrysopa, and by that of a member of the Syrphidæ. In addition to these, at St. Helena, Moreton Bay, a second kind of dipteron—a somewhat diminutive insect—appears to destroy it.

FUNGUS DISEASES.

Maize Rust. No. 1 (First stage—*Uredo Maydis;* second stage—*Puccinia maydis*).

A fungus met with on maize at Toowoomba has been identified, by Dr. M. C. Cooke, with this species. The symptoms which characterise its presence are scarcely to be distinguished from those which are associated with the diseased condition caused by *Tilletia epiphylla*, and it is scarcely possible to decide whether all the maize-rust at Toowoomba is caused by this Uredo, and not in part by the latter fungus also—in fact, the two species, without examination of the microscopic appearance of their spores, are so difficult to separate that Messrs. Berkeley and Broome, who defined the Tilletia epiphylla, at first pronounced it to be nothing other than Uredo maydis. Our acquaintance, as far as their injurious effects are concerned, is, however, limited to this *rust* fungus, and our notes, relating to observations made atToowoomba, may fairly be considered to apply to it exclusively.

Symptoms.—Spots or clouds of a greenish-yellow appear at various points on the leaves, or leaf-sheaths. These, according to

their size, contain one or many small brown swellings of a circular or elongated form. Each swelling having its origin in the parenchyma of the leaf extends to both pages of it, though not always so. When this happens, the figure of the protuberance on one side of the leaf need not correspond with that on the other. On examination of these weal-like bodies, it will be found that they are due to the epiderm of the leaf on either side being bulged out, and that this portion of the tissue is dead and brown-coloured, whilst the surrounding part of the leaf is also affected, and is yellow instead of green. During the progress of the disease the dead tissue covering the swellings becomes ruptured, and it will be noticed now, or by previous examination of the contents of one of these little weals, that the protuberances are caused by the accumulation of masses of reddish dust-like matter within the tissue of the leaf. This finely divided substance is made up of the uredo-spores of the fungus. These spores are very distinct in appearance from those of Tilletia epiphylla ; though the majority of them are circular in outline, others are regular oval, and, having a diameter of from ·001276″ to ·001489″ x .001″, are also larger. The epispore, or covering of the spore, is also in the case Uredo maydis much thicker, and is also darker in colour than is that of Tilletia epiphylla. Its surface, too, instead of being reticulated, and having regularly distributed elevated points, is comparatively smooth, having only a few linear rugosities of varying distinctness here and there. The epispore, in this fungus, also seems to almost fail at one or two obscure circular spots on the surface of the uredo-spore. These probably mark the position in which the mycelium will emerge when development first commences.

We first noticed *Uredo maydis* at Mount Pleasant, on 8th February, and Mr. Hitchcock, the proprietor of that estate, informed us that he had never seen it on his corn before. There, as elsewhere, it was found associated with the fungus of the maize disease proper, due, as we shall see, to another parasite—*Helminthosporium*, and not infrequently the two pests occurred not only on the same plant but on the same leaf also. Further, by gradual encroachment of the diseased condition, due to the *Helminthosporium* fungus, the pustules of the rust may eventually come to occupy a position within the areas of the tissue of the leaf affected by it. Notwithstanding, the nature and extent of the injury occasioned by the two fungi are very different. The maize disease proper covers a much wider area, and is apparently limited only in its destructiveness by the extent of the leaf itself. Moreover, it spreads over the surface with far greater rapidity, and is accompanied by no unevenness or rupture in the epiderm of the leaf which it has assailed, as happens in the case of *Uredo maydis*. This rust fungus of the maize probably exerts a much less prejudical influence on the health of the plant than does the analogous fungus in the case of wheat. At present we have not made the acquaintance of any Puccinia stage referable to this Maize Uredo.*

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* It has, however, been reported as occurring in other countries, where it is known as *Puccinia maydis*, Carr. Since the above account has been written we have received F. Lawson Scribner's description of both it and the Uredo stage, drawn up from American examples of affected maize. He remarks concerning the former :—

Puccinia Stage.—The contents of the later-formed pustules will be found to be almost black, and that " these black pustules are composed of dark-coloured spores (teleutospores), having a very different structure and function from the

Remedies.—Any remedies can only be of a preventive nature, and must be similar to those which experience may suggest as being serviceable in warding off the rust from wheat. Attention, however, to the proper cultivation of the soil is the first consideration.

MAIZE RUST, No. 2 (*Tilletia epiphylla*).

This disease has not come under our notice when examining growing maize; but we are indebted to Mr. F. M. Bailey, F.L.S., for typical illustrations of it, afforded by specimens identical with those originally forwarded by him to the undermentioned English specialists. In treating of Maize Rust No. 1 we have dealt with the differences which exist between *Uredo maydis* and *Tilletia epiphylla.*

Symptoms.—A dried specimen of a portion of a maize leaf very much affected by this disease presented the following appearances:—The normal green colour was here and there discharged and replaced by a rusty yellow, which occupied very irregular, cloud-like areas, much interrupted, and extending over some inches of the surface. In the midst of this altered tissue there were little protuberances; these marked the sites of spots where the epidermis on each side of the leaf was abruptly raised up. These little elevations were sometimes round, but at other times elongated in the direction of the length of the leaf; they measured from $\frac{1}{50}$in. to $\frac{1}{20}$ in. in diameter. The portion of epidermis raised up was not only dead, but the cells of which it was constituted were evidently stretched, and in many cases it was ruptured, exposing to view a light rust-coloured dust. Spots occurring singly on the leaf were found to be surrounded by a little halo of light rusty-yellow, and it was by the influence of several of these pustules which had originally arisen near together, that the cloud-like areas of the same colour had been formed. Sometimes these little spots of light rusty-yellow were present, but did not surround little elevations of distended epidermis, but in these cases a nucleus of some foreign matter within the tissue occupied by these spots could always be detected by the aid of transmitted light. The disease was evidently one which originated in the parenchyma of the leaf. On opening one of these protuberant bodies it was found that it contained numerous rust-coloured particles more or less compacted together, and arising from a little cushion of minute and short fibres. These particles are the spores of the fungus. Their general shape is round, with a diameter of .00010635 inch, but their symmetry is usually obscured by the fact of their having been previously compacted together. Their surface is thimble-punctured (reticulated) with little sharp elevations between the punctures, the reticulation being best seen when air is

uredospores. The stalks which bear them are stronger and do not separate from them. Each spore is broadly elliptical in outline with both ends rounded, or with the apex occasionally thickened and pointed. The surface is smooth. A partition is placed across the middle which divides the interior of the spore into two cavities. At germination each part may germinate independently, so that this may be called a double spore. At the partition the spore is constricted, and it is twice as long as broad; some are a half longer and broader than others, and the longest are a little narrower than the diameter of the uredospores. They measure ·0006 to ·0009 inch by ·0012 to ·0018 inch. They may be called resting spores, because they remain dormant throughout the winter and germinate the next season, again producing the rust and thus perpetuating its existence."—F. Lawson Scribner, in *Report of the Com. of Agr., U.S.A.*, 1887, p. 390.

present within the spore and the elevations on viewing its edges. Messrs. Berkeley and Broome thus describe this fungus :—

"Tilletia epiphylla (Berk. and Br.), n. sp. Pustulis brevibus epiphyllis, sporis globosis laevibus pallide fuscis."—*Rev. M. J. Berkeley and C. E. Broome,* Trans. Lin. Soc. Lond., 2nd Ser. Bot., ii., 3.)

"Pustules from $\frac{1}{4}$ to $\frac{1}{2}$ line in length, pale brown, occupying a yellowish spot on leaves of maize. Spores smooth, globose, about 0·004 inch in diameter, filled with granules. *Uredo maydis* DC. is a much larger plant, with much smaller spores." (Brisbane. F. M. Bailey, No. 221, p. 67.) List of F. from Brisb., Qd., with desc. of n. sp.

THE "MAIZE DISEASE."

I.—Digest of Previous Reports and Comments.

(a.) The following Report emanated from a blight-stricken district of New South Wales, and appeared in the *Macleay Argus.* It is written by Mr. E. Rudder, and forms portion of an article relating also to some errors in maize cultivation :—

"I do not think that disease of any kind, as a cause, had anything to do in the matter, but firmly believe that the mischief was caused by an extraordinary and unseasonable change in the temperature. It should be remembered that the failure of last year's crop was marked by some significant and characteristic features that rendered it peculiar. So far as the Bellinger, the Macleay, the Hastings, and the Manning, the attack was universal and simultaneous, and the result in all cases precisely similar. This being the case we must seek for some cause adequate to produce such an effect. The diseases common to maize, wheat, and other cereals, rust and smut for instance, are generally connected with some predisposing condition, such as excess of moisture, defective drainage, over luxuriance, &c. These and similar diseases make their appearance in detached spots, from which they spread with varying degrees of rapidity according as the conditions are favourable or otherwise: neither are the results always the same; they vary in the same field, and in a greater degree in the same district. Some localities may escape entirely, while in others contiguous, every plant is destroyed. Such being the case, it is useless to seek for the cause among diseases of the character before mentioned sufficient to produce a result like the failure of last season's late maize crop.

"To support my view of this matter I must draw attention to the fact that, shortly before the significant change in the appearance of the maize began to attract observation, we experienced a most unusual and violent change of weather, amounting to a transition of summer heat to the cold of winter—at the time it was reported that frost had been seen on several farms. I did not see it, but I do not question the statement, as the temperature seemed to be quite low enough to produce it. Prior to this phenomenon the weather had been for some time disagreeably hot, and the several districts had been favoured with a seasonable fall of rain. Stimulated by these favourable conditions, the late crop had made a rapid and luxuriant growth, and was looking splendid up to the day when the extraordinary change of temperature occurred. Now, sir, maize, though capable of resisting great heat and enduring drought, is very susceptible of cold; very slight frost will prevent the grain maturing, and severe frost will destroy the plant during any stage of its growth. Now, the frosts to which I have alluded happened at the time when the vital energies of the maize plants were in fullest activity; the violent change of temperature arrested the flow of sap, causing congestion, which resulted in the slow death of the plant. In every case I examined, the highest and most exposed leaves were the most affected; they partially withered, and their natural colour

changed to dark-brown and straw colour; the lower and better protected leaves remained for some time apparently unchanged—in short, the plant appeared to die from the top down. The effect on the growing cob was not discernible for some time after the leaves showed signs of dying. The change in their condition was made manifest by the husk becoming loose and changing to a straw colour. I examined many of them at this stage, and in every instance found that the grain had been formed and well developed up to a point corresponding with the age of the plant, the appearance exactly agreeing with that of ordinary frost-bitten corn; in no case did I see the slightest indication of disease."

Mr. Rudder's communication on the Maize Disease, as it presented itself in the Macleay district of New South Wales, was reproduced in the *Town and Country Journal*, Sydney, 16th January, 1886, with the following additional information :—

"We are in receipt of plants 'blighted' maize from the Macleay district, and have examined some under the microscope. The indications are similar, precisely, to those observed last year, in maize from the same quarter, from the Manning and also from Queensland. There are no appearances of fungoid growth, of smut or rust, no spores, or anything of that kind visible on the fresh plants, but the cells of the younger corn sent are ruptured in a manner which may prove sufficient to account for the wilting of the corn, the grain included."

(B.) "*Report on four samples of Maize received from River Hastings*"* *by E. Haviland, F.L.S.*

The report itself is a very brief one; it merely recites the fact that the disease is due to the presence on the maize plants of a fungus; and that this fungus is, in the author's opinion, *Ustilago Candollei.* The phenomena attending the growth and development of fungi of the class to which this Ustilago belongs; the general relation of leaf-parasites to their host plants; and the nature of the influence which they exert on those which they attack, are then referred to; as also the preventive measures which, in the case of the maize disease, should be resorted to in order to check its re-occurrence in places where it has once appeared.

No precise indication of the symptoms which characterised this disease, as found in the maize plants under observation, is given in the report; but from the "particulars of the examination of each parcel" we may conclude that the disease primarily was one of the vegetative organs—although the fungus which occasioned it was sometimes met with in the "cob." The following are some of the conditions noticed in different plants :—(1) "The whole of the leaves (were) dead through their entire length and clouded." (2) The sheathing portions of the leaves (was) much diseased and covered to some extent along the leaves by cloudy markings." (3) There were in this plant "symptoms of disease at the nodes (joints) of the stem." In another the disease formed "isolated spots," and in other plants it was found that the "leaves (were) slightly diseased," "mostly diseased—(the disease) extending somewhat to the cuticle of the stem" or "very much diseased."

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* In the character of "a most exhaustive report . . . . on the maize disease," this was submitted on the 15th February, 1886, to the New South Wales Government by the Chief Draftsman in the Department of Mines. It was officially circulated as a pamphlet (pp. 1-4) and was also printed in the *Sydney Morning Herald*, February, 1887, the Brisbane *Courier*, 9th March, 1887, and in several other newspapers.

The cobs seemed to have suffered in direct proportion to the intensity with which the disease was manifested, in the leaves or other parts of the plants which bore them. In one case "the cob had failed entirely, leaving only a small mass of (decayed) matter;" in other cases "two-thirds of the grain had disappeared, and many of these that remained presented a shrivelled, half-rotten appearance" and so on.

These descriptions of what Mr. Haviland really saw are couched in such general terms that no very precise conclusions as to the nature of the disease may be inferred from them; but we can have little doubt that the evidence on which he based his decision that the affection was due to the presence of a particular fungus, Ustilago Candollei, was purely imaginary; and even it were not, as far as it is set forth by him, it does not support his interpretations of the disease. Many text-books on botany record the results of the Rev. M. J. Berkeley's classical investigations concerning the development of ustilaginous fungi; but they do not all tell us, as was the case, that his description of the successive stages arrived at in the development of the spores of Tilletia—the fungus which he had before him—was the outcome of observations made on these spores after they had been isolated from the host-plant of this fungus, and related to their behaviour then; and that the phases in the life-history of this Tilletia to which he referred were not only successive in their event, but occupied some considerable time in their progress. Since 1847 numerous other investigators have repeated Berkeley's experiments, and, as we have his authority for stating, have not through their labours added anything to our knowledge of the subject. Notwithstanding, as it may be according to the fitness of things that the phenomena to which he directed attention then should be seen upon examining a diseased plant and within its tissues, so many, no doubt, have imagined that they saw them in this situation; but it has been granted to Mr. Haviland alone to discover the existence of "the mycelium of the fungus Ustilago . . . . . . with masses of pseudo- and true spores (of the same fungus), forming a grumous mixture, completely choking the vessels, in a portion of the sheathing of the cob of a maize plant; pseudo- primary and secondary spores (together) in particles of decayed matter taken from an abortive cob," or "some few spores (of Ustilago) in the ovary of a grain (of maize derived from a diseased plant) *germinating*." Moreover, the objective presentment of an Ustilago, to quote the definition given by the author of the "Handbook of British Fungi"—M. C. Cooke—is a fungus which, with other characters also, has "spores of one order" only.*

Ustilago Candollei, *Tulasne*, is a fungus which was published by M. C. Cooke in his "Fungi Britannici Exsiccati," 2nd series, No. 72, and referred to subsequently by him, in the "Grevillea," as occurring on the flowers of Pelargonium. There are, however, other ustilaginous fungi, which are known to affect maize and this plant only. These are :—(1) Ustilago Maydis (*Corda*), first described by De Candolle in *Flore française* (vol. vi., p. 77), under the name of *Uredo Maydis*. This occurs in different European countries, and in America, but according to Cooke, "we have no knowledge of Australian specimens."† It is known as the "maize smut," and

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* *Op. cit.*, p. 511.

† "Australian Fungi" in "Grevillea." Vol. xi., 1882-3, p. 98.

forms "excrescences more or less voluminous, and deformed" on the stems of this plant—the bracts and ovaries being also involved in similar enlargements. These enlargements ultimately break down into dark powder—the spores of the fungus.* (2) Ustilago pulveracea (*Cooke*), a pulverulent fungus "occupying the male florets (of the maize), but very different in habit from U. maydis." It has hitherto only been found at Lahore, and not in Australia.† Finally there is (3) Tilletia epiphylla, *Berk.* and *Broome*, a fungus which forms "pustules from $\frac{1}{4}$ to $\frac{1}{2}$ a line in length, pale brown, occupying a yellowish spot on leaves of maize." This has "spores smooth, globose, about 0·0014 inch in diameter, filled with granules."‡

From this review of the known ustilaginous fungi which affect the maize, it will be very evident that Mr. Haviland had none of them before him, and from a consideration of the character presented by numerous other species of this group, it seems highly probable that no member of it was concerned in producing the diseased conditions which he describes. As concerning preventive measures, his opinion is worth consideration. He remarks (p. 2): "Nothing, I think, can be done to save a crop when once affected; but I should earnestly advise those concerned, as preventive measures for future crops, to destroy by fire all culms, roots, and leaves of the present diseased crop; to avoid planting maize year after year upon the same ground; to obtain seed for the next planting from some distant source, *where it can be ascertained that there has been no disease* (the italics are ours); and by taking such measures, best known to practical farmers, as are likely to increase the vigour of the crop, and thus to give it every chance of resisting the attacks of this fungus should it again make its appearance."

(c.) *Report on the Maize Blight to the Board of Technical Education of New South Wales. By Wm. Morris, F.F.P.S.G., and F.R.M.S.L.*

This is as follows:—"I have examined, microscopically, the sample plant of diseased maize you sent me; also several specimens fresh from the country, which Mr. Mackay, of the *Town and Country Journal*, kindly obtained for me. Your specimen consisted of one plant and three cobs of corn, evidently having been gathered several weeks. The specimens received from Mr. Mackay were still green and fresh, only a few days old, and consisted of several stalks, leaves, and one cob of corn, not ripe. The first three cobs were grown to maturity, fairly healthy, a little pinched in the grain. The other was not ripe, and appeared to be in good condition; no diseased grain in either sample. On the stalks and leaves I cannot detect any rust or smut (*Ustilago*). The various fungi that are visible arise from the decay of the dead portion of the leaves, and these black fungi are always to be found on decaying vegetable matter. There is not the

* For a description of the history, external appearance, and the fungus, &c., of the disease due to this Ustilago, the reader is referred to an able article by A. B. Seymour in the Report of the Commissioner of Agriculture, U.S.A. 1887, pp. 380-389, pl. xii., xiv.

† "Some Indian Fungi," by M. C. Cooke, M.A. Grevillea, vol. iv., 1875-6, p. 115.

‡ "List of Fungi from Brisbane, Queensland, with descriptions of new species," by Rev. M. J. Berkeley, and C. E. Broome. *Trans. Lin. Soc.* Lond., 2nd Ser., Bot., ii. 3, 237.

least sign of any swelling, contortion, or distortion on any part of the plants, which would be if it had been attacked with a Ustilago (smut). . . . From the examination of the above specimens, it appears to me that the plant having been stunted in the early part of its growth, probably from want of sufficient moisture, a copious sudden fall of rain taking place, the plant absorbed more moisture than it could properly utilise. This caused the stem to increase in size quicker than its siliceous cuticle could bear the strain of, causing small fissures to be formed in the stem near the joints. The cellular tissue now being exposed to the action of the air, fermentation immediately set up, the torulæ spores sent out their filaments (mycelium), which ramifying through the cellular tissue caused decomposition at the joints, and a gradual decay of the leaves, which now became covered with the minute black spots, which are the fungal scavengers of all decaying vegetable matter. From these observations you may dismiss any idea of a fungoid (rust or smut) character : you may call it maize gangrene, or cellulitis, as there are any amount of bacteriæ to be found on the diseased vegetable tissue at the joints."*

It may be concluded that the specimens with which Dr. Morris was furnished, and on which his report is founded, were scarcely typical illustrations of the maize disease. It will be noticed that he incidentally notes the occurrence on these plants of what he describes as "black fungi arising from the decay of the dead portion of the leaf," or in other words "a gradual decay of the leaves which became covered with minute black spots." These black spots were present on the plants at the time when he received them, but he regarded them merely as secondary symptoms or examples of "the fungal scavengers of all decaying vegetable matter," and it does not seem to have occurred to him that they might have existed on the plants when they were still growing. In the case of the Torula fungus in the tissue† the explanation given was no doubt the proper interpretation of its presence. Thus he concluded that the maize disease owed its origin, or was caused by purely meteorological events.‡

Dr. Morris afterwards—in May, 1886—read a paper on the maize blight, illustrated by four preparations of the fungus, at a meeting of the Microscopical Section of the Royal Society of New South Wales. In this the author concludes that "the fungus growth belongs to the *Torulacei*, having no perithecium nor investing membrane to the spore cases. The fruit forms the greater part of the plant, and grows on the fertile threads in moniliform chains of spores. The spores formed from the deciduous joints may be simple or articulated. As the spores comprise the principal part of the plant, many of the spores become pulverulent, the spores being diffused through the air in an impalpable dust."

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* *Austr. Medical Gazette*, April, 1886, p. 183.

† P. A. Saccardo has figured a Torula which, as far as is known, is peculiar to the decaying tissue of maize. It is named Torula moniloides, *Corda*. This representation is to be found in *Fungi Italici Autographice Dilineati*, No. 948.

‡ That these views concerning the maize disease did not meet with general acceptance may be concluded from the fact that "owing to the discussion on the report submitted by Dr. Morris, the Board of Technical Education resolved not to publish it." It would appear however that had Dr. Morris received in the first instance better material with which to prosecute his investigations, these views regarding the value of them might have been considerably modified.

(D.) *Report on "Disease in Maize Crops" to the Board of Technical Education of New South Wales. By Angus Mackay, Instructor in Agriculture.**

Amongst matter which is somewhat foreign to the inquiry, such as that which relates to the condition of the maize crop in different districts of New South Wales, and the manner in which seed corn should be selected, Mr. Mackay informs us that "the symptoms of the disease are—first, an unnatural paleness of the leaf; then, appearances of dirty, whitish-looking spots and patches." With reference to its immediate cause he remarks: "Maize leaves and plants . . . . . with the whitish blotches and black specks are found to contain the germs of fungus growth;" again, "microscopic examinations . . . leave no doubt that fungus growths have much to do with it." On the origin of the disease he makes this suggestion:—"It may be that the trying seasons, 1884-5-6 have, by their exhausting effects upon this hitherto (in Australia) very hardy and perfectly healthy crop, developed an indigenous parasite until it has become an epidemic, and threatens a real danger to a most important industry. Or the fungus may have been introduced in seed corn, or in the very damaged maize landed here in large quantity from Islands of the Pacific during the years of scarcity mentioned." As to its seasonal occurrence he states: "Early planted corn suffered to some extent—that is, the plantings made during August and September. That planted during October and November seems to have suffered most. The later plantings, between Christmas and New Year—a favourite time for late corn—and the early January plantings, are doing better, and very fair returns are expected." Mr. Angus Mackay also incidentally alludes to the fact of Mr. Hugh Pollock, Acting Secretary to the Board of Technical Education, having investigated the maize disease, and informs us that "His report to the Board expresses a belief that the fungus developed on the maize 'is allied to Puccinia graminis, the cause of rust in wheat, but belongs to another genus.'"

(E.) "*An Inquiry into the Maize Disease of the Caboolture District.*" *By J. Bancroft, M.D.* †

This investigation was the outcome of a request, made by the late Colonial Secretary, Sir S. W. Griffith, that Dr. Bancroft would "inquire into the causes of the maize blight reported to have visited the Caboolture district" of Queensland. During the inquiry a blighted crop was visited near Luggage Point; but, primarily, the conclusions obtained were the result of an examination of some specimens forwarded by those through whose petition the report originated. Of these samples of diseased maize sent—No. 1 was the young plant showing the disease; No. 2, an older one; and No. 3 one which had arrived at a stage when "the disease makes rapid growth—the leaves are soon killed and the cob does not fill out." The secretary of the Farmers' Association at Caboolture, who had forwarded these specimens with the above information concerning them, referred to the disease

* This report appeared in the *Sydney Mail*, 2nd March, 1887, and also in other newspapers.

† A paper read on 4th June, 1886, at a meeting of the Royal Society of Queensland, and contained in the "Proceedings" of that Society, Vol. iii., pp. 108–111.

with which they were affected as "rust"—*i.e.*, a disease of fungus origin. Amongst other abnormal appearances which they presented, Dr. Bancroft found that "the foliage (of these plants) had dead strips running longitudinally in parts of the leaf," and concerning this condition he remarks : "How this was caused, whether by bruising from wind or by some obstruction to the vascular tissue was not evident. No fungus was found on the foliage." It was noticed also that there were "caterpillars in the immature ears as well as in the stems" of the plants sent; and that "in a blighted crop every stem of maize was perforated by caterpillars." It had been reported that a good many blighted maize plants, at Caboolture were affected with a boring caterpillar, and that in other districts, "the caterpillars had extensively bored within the stems of all blighted crops," and so, as Dr. Bancroft adds, "it was clearly evident that the stalks being bored extensively, both below the ears and between them and the upper flower, they (*i.e.*, the caterpillars) had spoiled all chance of grain development."

The caterpillars, however, were not the cause of the maize disease, which it was intended should form the subject of the inquiry. They had "been more or less prevalent in the late maize crops (at Caboolture) for years," although it was not so in the case of this disease ; moreover, an opinion had been formed there "that they had not much to do with the so-called rust," and they were not present in all blighted maize plants. We may therefore point out that though the information concerning the moth, *Conogethes*, and its relation in this caterpillar phase to the maize and other economic plants with which the report mainly deals, is interesting enough, the investigation failed inasmuch as it did not discover what was intended—viz., the cause of the maize disease of the Caboolture district, and incidentally that of the malady affecting maize in Queensland and New South Wales generally.

II. An Attempt to Elucidate its Nature.

Symptoms.—The first symptom seems to be the appearance of small elongated blotches of whitish green on the blade or lamina of the maize leaf, which soon expand in every direction. Those portions of these blotches which have earliest arisen then assume a light-brown colour, and this hue shortly entirely pervades them as the death of the tissue supervenes. Meanwhile by the gradual extension of these affected areas, those blotches which are neighbouring, though at first remote from one another, become confluent, so that, ultimately, the whole blade of the leaf—including even the distal portion of the midrib —is affected, and presents a dead and shrivelled-up appearance. The midrib itself is the last part of the leaf to be affected, and as it for some time retains its normal position and colour, whilst the blade of the leaf on either side of it is already dead and shrivelled up, a very characteristic appearance is thereby presented. These patches of altered tissue become well defined soon after they first appear. Their borders, which are usually a little darker in colour than are the other parts, are irregular, but simple ; and the portions of the maize leaves which are involved in the disease, instead of retaining their previous toughness, are now very brittle, and break to pieces with facility on being compressed. The disease seems to commence near the apex of the leaf, and to afterwards extend towards the leaf stalk, also to attack the lower leaves of the plant in the first instance. The progress of the disease, however, is not invariably marked by such a succession of events.

Nature of Disease.—The form assumed by the disease would leave little room for doubting as to its immediate cause being the presence of some fungus, and microscopic investigation confirms this view. On close examination of the affected portions it will be found that here and there on the faces which correspond to the under surface of the leaves, the pervading light-brown colour of the blotches presents a blackish hue. This appearance, as may be discovered by aid of the lens, is due to the presence of minute black bodies. Further microscopic examination reveals the fact that these bodies are each composed of little blackish threads, which radiate in twos and threes, or even fives, or, more rarely, they arise singly, in an irregular manner, from spots pretty close together. These thread-like bodies are simple or unbranched, but jointed; their length is variable; their breadth is nearly uniform, though they are occasionally, here and there, somewhat constricted; they are variously bent, and are dark-coloured. Amongst or supported by these threads, technically known as *flocci*, are fewer stouter and also jointed objects of a more or less irregular fusiform shape. These are the spores of the fungus. The actual disease itself, which is co-extensive with the area of discoloured tissue, is somewhat in advance of this outward manifestation of spores and flocci, for there is usually, external to the latter, some affected portion unoccupied by these little tufts of thread-like bodies. But whatever part of the tissue involved in the disease be examined, on dissection it will be found that the mycelium or vegetative organs of the fungus always occupy the intercellular spaces.

Although we have not established the fact of this being the case, it is probable that each of these discoloured patches merely marks the part of the leaf where the fungus, whose mycelium pervades the whole tissue of the plant, has, perhaps, under the influence of climatic circumstances, arrived at a condition favourable for the development of reproductive bodies rather than that each marks the situation of a point at which the leaf has been independently infected by the fungus: and we are inclined to this opinion since the spores and flocci arise from the under surfaces of the affected leaves.

This fungus, associated with the diseased condition of the maize, is a species of Helminthosporium (spores worm-like), a genus belonging, according to M. Cooke, to the natural order Coniomycetes, and one, the very numerous species of which are found growing on the surface both of dead and living herbaceous or ligneous vegetable tissue.

This species has the following characters:—Tufts or fascicles of one to five flocci; flocci of a dark-grey colour sub-pellucid of different lengths; septa 3-6; cells about eight times as long as broad, sometimes constricted by lateral shallow depressions, or more rarely knotted; terminal cell rounded and shortened, sometimes almost globular; basal cell usually expanded. Spores regularly or irregularly sub-fusiform, of same colour as flocci; 2 to 5 septate; cells usually unequal; endochrome often very distinct and remote from walls of cells.

A fungus belonging to the same genus, Helminthosporium, is already known as occurring in maize in the United States. It is named *Helminthosporium inconspicuum* (M. C. Cooke *et* J. B. Ellis).*

* "New Jersey Fungi," *Grevillea*, vol. vi., pp. 88-9, pl. 99, fig. 19, March, 1878.

The authors of this species assign to it the following characters :— Tenuissime effusum. Hyphis elongatis, septatis, nodulosis, pallide brunneis, sporis lanceolatis, 3-5 septatis; episporio tenui—on Zea Mays. Effused, but so thinly as not to be visible to the naked eye. Spores ·08—·12 x ·02 mm.; at first with the endochrome divided, at length septate.*

It will be seen, on comparing this description with that given as relating to the Helminthosporium of the Toowoomba district, that there must be a close affinity existing between the two fungi to which these characters refer, and since they are met with on the same plant, and neither occur on any other,† a probability is engendered of their being one and the same.‡

This maize disease has been noticed as occurring in the Toowoomba district during previous years, and it would seem that it is getting more pronounced in places where it has once shown itself. It continues to visit places where previously its presence has not been observed or even suspected. Thus at Mount Pleasant it manifested itself for the first time during 1887. The fungus will appear on the maize at any stage during the growth of the latter. We have seen it on plants when only a foot high—in this case on late maize, and also when the cobs are within two weeks of ripening.

We found at Toowoomba that the invasion of a patch of corn of maize by this disease, judging from the external manifestation of its presence only, was both sudden and rapid. The determining events which are responsible for it are such as favour the incursions of similar blights of fungoid nature on other plants—especially cereals—and these events are damp weather—especially the prevalence of fogs and mists. Such climatic circumstances were experienced on Sunday, 6th February, 1887 ; and, as a consequence of this, the disease appeared in the maize subsequently, and when but two or three days had elapsed. This happened on quite a number of farms. To give but a single instance, we may mention that on Monday, 7th February, during an inspection of the farm of Mr. M. Stenner, we found some late corn which was growing there to be in a perfect state of health. Seeing Mr. Stenner again on 21st February, he reminded us of this fact, and at the same time stated that the "disease" had invaded this patch of corn almost immediately after our visit. This sudden and simultaneous occurrence of the disease in so many corn-fields, has led several to conclude that the series of meteorological events which precede this occurrence have been its immediate cause, and that the fungus, therefore (although we have not met with anyone who has seen it), has settled and developed wherever the symptoms of this, in that case constitutional, disease have existed. We have, however, to note that no cases of the "disease" are to be met with in which the fungus, Helminthosporium, does not occur; that it is an early symptom

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* M. C. Cooke and J. B. Ellis. *L. c.*

† The variety, however, named *Britannicum*, Grove, *Journ. Bot.*, 1885, p. 165, does occur on grasses at Salford Priors, England (*Vid.* "Grevillea," xiv., 1885-6, p. 133).

‡ Since this was written, Dr. M. C. Cooke has identified, as we anticipated, this fungus of the maize with the Helminthosporium inconspicuum, C. et. E., of New Jersey, U.S.A.

of the maize-disease, and also that its external growth is not on the upper surface of the leaf, in which position spores borne by the wind would naturally settle and thereupon germinate, but arises from the under side of it. It is entirely conformable to reason, then, to suppose that this series of meteorological events is not the immediate cause of the disease, but has been decisive in determining the growth of the reproductive organs of a fungus which, in a mycelium state, has previously pervaded the tissue of the maize plant, and has so permitted the Helminthosporium to develop a phase under which its presence becomes the cause of disease—robbing the tissue of its vitality. And it is a well ascertained fact that many fungi exist as congeries of mycelioid threads only, and are propagated in this condition, and that the occasions suitable for the development of ordinary reproductive bodies—such as sporogonia, spores, etc., so rarely occur, that these fungi have never been met with endowed with bodies of this nature. It has been found also that a plant will grow to its greatest perfection when the soil contains 40 per cent. of the total quantity of water which it is capable of holding as a constituent element. The capacity of the Toowoomba soil for water appears to be very high and, no doubt, after prolonged wet weather, this capacity will become nearly satisfied. Its nature also is such as to maintain this state of things for a considerable time. This abnormal increase, then, of constituent water in the soil, which will characterise the occurrence of wet seasons, cannot but have its effect on the growing maize, and increase the water in its sap. Now, this state of things will form a factor favourable to the development of endophytal fungi, and hence the prevalence of maize disease at such seasons.

The influence of this disease on the total yield of corn is often very marked. In one plot which we examined—that of Mr. Feljenhauer, and in which the cobs had already freed themselves from the leaf-stalk, these cobs were only half covered with grains. With regard to those grains, that in these cases still remain, it may be concluded that such an impairment of the function of the vegetative organs, as this maize disease must occasion, cannot but have its effect in depreciating the value, for food material, of their constituent elements.

The seasons at Toowoomba are very irregularly defined, and favourable conditions for the development of the fungus of the maize disease may thus occur at any time, and therefore during any stage in the growth of the corn. The maize disease must be regarded, then, as one of the unavoidable risks incidental to the growth of this cereal, and one which it will be necessary to take account of in forecasting the value of a crop whilst the corn is as yet immature. The disease, too, it would appear, does not spare any particular variety of corn, and also affects "late corn" as well as that planted in the ordinary season, neither can its presence be correlated with defective cultivation or any other circumstances which can be modified by human agency.

Note.—To our view respecting the nature of the Maize Disease, it may be objected that we have mistaken for its active cause a fungus organism which only affects maize tissue in which the vitality has already ceased, and that decay has been previously determined by the attacks of plant-eating insects—in fact, that we have confounded cause and effect. Such a suggestion may certainly be made with some *show* of reason, and to those who may be inclined to adopt such an explanation regarding the

origination of this formidable malady, we would refer to our article on the "Maize Leaf-hopper" (*vid.* p. 193), and to our remarks concerning this subject in dealing with that pest.

Remedies.—The progress of the disease being dependant on the growth of a fungus within the tissues of the maize plant affected, cannot, as is very obvious, be checked. We can, however, resort to preventive measures, such as those which have been generally advocated by Mr. E. Haviland in the following recommendations:—(1) Destroy by fire all culms, roots, and leaves of the present diseased crop; (2) avoid planting maize year after year upon the same ground, (3) obtain seed for the next planting from some distant source where it can be ascertained that there has been no disease;* take such measures best known to practical farmers as are likely to increase the vigour of the crop, and thus give it every chance of resisting the attacks of the fungus should it again make its appearance.

The development either of this particular fungus or of closely allied ones being unknown, we are ignorant of how one maize plant infects another growing in its neighbourhood; nor are we assured, even, that such infection really takes place, and that the Helminthosporium does not persist from season to season through the intervention of mycelium developed within the tissue of the maize plant, and occurring, amongst other parts, in the seed itself—as Worthington Smith has shown really happens in the case of the rust-fungus of wheat. But, in any case, the spores must perform an important *rôle* in the propagation of the fungus even if they are not the only medium of its increase, and we can only point out that the discovery of a complete preventive remedy of the "maize disease," unless arrived at empirically, will only result from the ascertainment of the influence of certain bodies on the spores in arresting their complete development in a similar manner, as has been done by Millardet and Gayon in their investigations of the action of lime, sulphate of iron, and sulphate of copper, respectively, on the spores of the "mildew" producing Peronospora of the vine.† As in the case, however, of the maize, it will be impracticable to apply any solution to the growing plant, our attention will have to be restricted to those which are absorbed by the roots of this plant without decomposition, and from the agents, which investigations have shown to be available those which are in other respects poisonous will perhaps have to be eliminated; although generally, as has been shown in the case of copper—the hydrated-oxide of which is slowly soluble in water containing carbonic acid and ammonia, these would be present in far too small quantities to exert any prejudicial effect on consumers of maize. To illustrate our meaning, we may state that Millardet and Gayon found that the limit of concentration incompatible with the complete development of the reproductive germs of the Peronospora of the vine was, in the case of lime, a solution of 1 to 10,000 parts; for sulphate of iron, a solution of 1 to 100,000; and for sulphate of copper, 2 or 3 to 10,000,000.

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* This recommendation points to a significant fact relating to the source whence Australia derived her "maize disease." For *Helminthosporium inconspicuum* has never been met with on maize in Europe, but does occur, where hitherto its presence has alone been remarked, in the United States of America.

† *Cf.* Article in *Journ. d'Agric. Pratique*, Nov. 12, 1885, translated in "Report on the Fungus Diseases of the Grape Vine," pp. 108-112." Washington, 1886.

CHAPTER X.

Cereals—*Continued.*

WHEAT.

Rust.

A New Mode for its Dissemination.

The presence of wheat mildew, like that of some other fungi, is characterised by certain well-known appearances on the plants which it infests, and it is usually considered that this fungus has a limited local development, co-extensive only with these rust spots. Recent researches, however, tend to show that the vegetative system of the fungus—*i.e.*, the mycelium, pervades the whole tissue of the plant, and that this rust fungus only becomes markedly injurious when, in response to the influence of certain meteorological events, it develops reproductive bodies, which are those which constitute the "Rust" as ordinarily understood. This consideration explains the fact, that whilst in some cases of rusted wheat one plant may directly infect another by the sporidia being conveyed by wind, or even owing to contact, from the injured leaf on to the surface of the previously sound one of a neighbouring or even distant plant, yet in other cases—and since the duration of the faculty of growth inherent in the spore is—as is now known—of very limited duration, no such infection can have taken place, but the fungus must have persisted from season to season, through the intervention of mycelium or directly formed mycelial bodies contained within the plant tissue—in other words, the "rust" may become hereditary in the wheat, the fungus existing in the seed, and from thence extending to the tissue of the growing plant immediately arising from it. The best proof that we have that this is so is afforded by facts which can bear no other interpretation, and which have been made known by Mr. Worthington G. Smith, relating to different fungi, but to the wheat "rust" especially. After recounting his observations on the development of the last mentioned fungus, he states the case before him in the following words:—"I have proof that not only does fungus mycelium often hybernate within the membrane of seeds, but resting spores are sometimes produced within the seed membranes, and these resting spores germinate with the germinating seeds. In other words, many diseases of plants, as corn mildew—Puccinia graminis, are hereditary—*i.e.*, the diseases of the parent plants are transmitted direct to the seedlings by infected seeds."*

These facts discovered by Worthington G. Smith, and alluded to in the above passage, throw important light on what has hitherto been regarded as an enigma—namely, how fungus diseases known in one district only, suddenly appear in a remote one to which not plants but seeds only have been conveyed from the previously infected district—and, for instance, may explain the sudden apparition of a North Carolinan maize fungus (Helminthosporium) on the plants of this cereal grown both in New South Wales and in Queensland, constituting the formidable "maize disease"; and how, in experiments conducted in the

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* *Gardener's Chronicle,* 4th July, 1885, p. 21.

direction of the discovery of a blight proof wheat, seed procured from a distance has sprouted into a plant which, though protected, develops "rust."

*On the Rôle of Silica in the Wheat Plant, in Determining a Comparative Immunity from the Attacks of the Rust Fungus.**

It is well known that silica is one of the components of the inorganic skeleton of the cell wall of plants, and that though this is so, its total amount in any plant may vary to a large extent without the normal structure of that plant being departed from, and this is especially so in the case of cereals. But though this variation, within certain limits, in the quantity of silica may have little or no influence in enabling a plant to retain its physical structure, it may to some extent determine its capacity or otherwise for withstanding disease, and thus the opinion has been expressed that wheats which are poor in silica are especially subject to the attacks of rust, and more frequently than other wheats, succumb to that disease. Mons. M. Gneymard, in 1859, even went so far as to attribute to this deficiency in silica the cause of the rust, at the same time stating that the wheat plant should contain as much as 60 per cent of this mineral.† Again, more than twenty years since (as we are informed in the *Queenslander*, of the 30th May, 1887) there was a pamphlet published by J. J. Moore, of Sydney, the title of which was "Rust in Wheat." The theory presented by the author was, that the development of the disease was attributable in part to the deficiency in silica—such an important element in the straw.

The reason which led in either case to the expression of this opinion as to the influence of silica is not forthcoming, but it was probably founded on the observation that wheats in which this mineral was deficient were more subject to rust than were those in which it was largely represented as a constituent body.

In the case of M. Gneymard, this view received confirmation from M. Bouquet, an agriculturist of great experience, who recorded as the result of his own observation that—in the province of Marn, where—as in the neighbouring arrondisements—the soil reposed on a great bed of chalk, and, though rich in nitrogenous matter, was accordingly largely composed of carbonate of lime, the wheat crop was always very subject to rust. With M. Gneymard's opinion before him, he was now able to explain this; as also the fact, which he too had noticed, that all varieties of wheat did better on land which contained silica; that all wheats seemed to require this mineral—even the short-bearded varieties which could do with the least amount of any; and lastly, that when wheat-growing in such a soil as he had described was manured with compost rich in nitrogenous plant food-substances, the crop, as far as immunity from rust was concerned, did best which received the manure which, though in other respects the poorest, contained the largest amount of silica.

The opinion too receives further corroboration from the experience that, of so-called rust-resisting wheats, the hard wheats—*i.e.*, the

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* This portion of the Report was read at the first session of the "Australasian Association for the Advancement of Science," and was printed *in extenso* in its "Proceedings," *vid.* p. 343.

† Comptes Rendus, 1859, xlix., p. 547.

pericarp of whose seed contains an unusually large amount of silica—are those which withstand the attacks of this fungus in the greatest degree. And the unusually large amount of silica contained in the skin of these hard wheats is indicative of the fact that the whole plant is unusually rich in this mineral also.

No attempt to arrive at an explanation of the rôle performed by silica in this connection has, as far as we can learn, ever been made. Now, it may be assumed that the rust-fungus lives and grows at the expense of bodies genetically related to sugar—*i.e.*, the glucosides, or soluble forms of starch which it finds in the parenchymatous tissue of the leaf, where it is located, either within the cells or the cell walls, or as most frequently in the intercellular spaces. And that it does so subsist at the expense of the soluble forms of starch and gluten is plainly indicated by the fact that these bodies are almost absent in "rusted" wheat plants. This food-material is derived from the starch of the neighbouring chlorophyl-containing tissue, from which it passes by a process of osmosis, glucosides possessing the greatest power of endosmosis of all vegetable substances of equal density with them. The degree of osmosis, however, for the same body, varies with the composition or nature of the membrane through which it takes place, and nothing so much determines its amount as the presence of silica to a greater or less extent, vegetable substances especially—as is a well ascertained fact—being permeable by osmosis in indirect proportion to the amount of silica which they contain. The formative substance, then, of the cell walls of the tissue of a wheat plant when largely composed of silica, would, therefore, form a much greater hinderance to the passage of these food materials of the Puccinia to the tissue in which this fungus grows, than would one in which silica was little developed; in other words, non-siliceous wheats would be those which were most favourable for the support of the Rust Fungus.

This explanation amounting to the establishment of an *à priori* probability as to the siliceous wheats being comparatively rust-proof is corroborative of the experience that they possess this character, and we can only point then to the desirability of growing wheats of this class. It is not merely necessary for us to sow hard wheats, for the character of the succeeding generations derived from this seed will possess this character, or not, according to the nature of the soil on which they are raised. That wheats may be made to, and do, differ in respect to the amount of silica they contain might be regarded as certain, even if it had not been demonstrated to be the case by actual experiment, when it is considered that all the varieties of wheat have arisen from a few—at most—different kinds, and chiefly under the influence of change of soil. We are, however, enabled, by way of making this appear more evident, to state, on the authority of Lyon Playfair, F.R.S., and by reference to a "Table showing the Composition of the Ashes of Wheat" which he quotes as follows:—The grain of a wheat—"Hopetoun Wheat"—on analysis by Messrs. Way and Ogden was found to contain 5·91 per cent. of silica, and on being used as seed gave, when grown on one soil, 1·42 per cent. of silica, and 2·84 per cent. (or just double the amount) on another; finally the same Hopetoun Wheat when grown on a sandy soil retained its character and the silica in its grain amounted then to 5·63 per cent. Analyses of the grain of another wheat, viz., "Red straw White

Wheat," showed that the silica in it ranged from 2·05 to 9·71 per cent., according as it was grown on "loamy soil in the Greensand" or "calcareous soil in the Magnesian Limestone formation.* From this it may be seen that wheat originally rich in silica, on cultivation may become poor in that mineral, and that the proportion in which silica is present depends on the nature of the soil—a nature which can be modified by ordinary agricultural processes.

The manner, however, in which a soil poor in assimilable silica may be rendered well endowed with respect to this mineral will be best indicated on consideration of the process by which the plant obtains its silica component from the ground. The direct assimilation of soluble silicates being as a theory dismissed for reasons which are immediately adduced, we may state that it is now usually held that silicon is taken up by plants in the form of a very dilute solution of silicic acid, or as gelatinous or collodial silica, and not directly in that of the soluble silicates of soda or potash, these salts, even if they could exist in a soil poor in uncombined silicic acid, being decomposed at the points of contact of the root hairs with the soil and by the carbon dioxide which they exhale. This is the view taken by the justly celebrated plant physiologist, Julius Sachs, Professor of Botany in the University of Würzburg. He adds, that by far the larger part of this silicic acid passes into the insoluble state within the cell walls; but he does not, however, refer at all to the soluble alkaline silicates.

That silica is, too, taken up directly by the roots in a minutely divided state, and by some process unrecognised by vegetable physiologists, seems also probable in view of a discovery, announced by Prof. P. B. Wilson, of the Washington University, that diatoms—*i.e.*, microscopic organisms whose frustules are almost wholly siliceous—are present within the tissues of the straw of wheat, grown under circumstances favourable for their obtainment, and to adopt the title of his memoir on this subject, that "Silica of grasses and other plants is carried up as diatoms or other siliceous grains, and not in a solution as soluble silicates.† In this record of his researches, Prof. Wilson states that he found generally that the silica in the ash of plants, obtained by slow incineration had different properties from "silicates soluble in acid or those decomposed with sodium and potassium carbonates," and that its appearance showed that it had been assimilated in a free state. Further, that the straw of wheat grown in infusorial earth, contained under this circumstance siliceous matter wholly composed of the siliceous shields of Diatomaceæ in their original form and identical with those contained in this earth—the larger discs only of the species being absent. The question of how these siliceous grains do, as it seems they do, effect an entrance into the plant-structure, through the medium of its roots, is not discussed by Prof. Wilson, but it would appear to us that the explanation will be found in the quite recent researches of H. Marshall Ward, M.A., F.L.S., relating to the entrance of some germinal elements of a particular fungus into the root hairs of the vetch.‡

* "A Cyclopedia of Agriculture," edited by John C. Morton, s.v. "Ashes," vol. i., p. 143.

† American Journ. Sc. 1876, xi., pp. 373-4.

‡ *Vide* "The Tubercular Swellings in the Roots of the Leguminoseæ." Proc. R. Soc., London, xlii., No. 255, p. 331.

We may next consider the value of the Darling Downs soils in respect to their possession of assimilable silica. Are they rich or poor in this essential of the properly constituted wheat plant? Some light may be thrown on the subject by an examination of its soils, but it would seem that our immediate inquiry will best be answered if attention is confined to wheat plants raised there. What amount of silica, then, do they contain?

Unfortunately, however, we have no data which will supply this information. The constitution of the straw of wheat raised in the wheat-growing districts of the colony, and especially on the Darling Downs, has not been made the subject of scientific investigation, but that the wheat raised in the latter district is poor in silica is a very prevalent opinion. Thus "A Farmer's Friend" in the *Queenslander*, 30th May, 1887, states, "If any of your readers will compare the wheat straw which they will remember to have seen in Britain with that grown on this side of the world, I think they will find a great difference, the latter being much softer than the former."

We fare little better when we come to investigate what is known concerning the physical or chemical nature of the Darling Downs soils. An analysis made in England by T. Hughes, F.C.S., of a soil from Killarney, which the late Mr. R. Daintree described as being "a fair average sample of black soil of the Darling and Peak Downs, and of the volcanic districts of Queensland generally," showed that this soil yielded on analysis 49·416 per cent. of insoluble, and 17·944 per cent. of silica soluble in alkali, or a total of 67·360 per cent. of silica*

Again, from analyses made by Mr. K. T. Staiger, of nine samples of what he designates "dark rich chocolate brown soil . . . especially adapted for wheat-growing," and procured by this chemist from the northern Darling Downs, near Jimbour, we find that they contained on an average 17·411 per cent. of silicia soluble in alkalies, and 51·317 per cent. of insoluble residue, or a total of 68·728 of silica and clay.†

According to an analysis made by Professor Way, we find, on calculation, that the amount of silica removed from the soil by wheat, taking the average of twenty crops, was 80 per cent. of the total quantity of material obtained by it from this source, or 12 per cent. more than M. Gueymard (*vide* p. 343) stated should be the proper amount in which this mineral should be present in the same cereal. From the investigations of Professor Wilson, to which we have alluded, the state of the division in which the silica exists in soils, when testing their capability of growing siliceous, and so perhaps rust-resisting wheat, becomes a matter of great importance. As far as we are aware no mechanical examination of Darling Downs soils has been made, and in the absence of the information derivable from such examination the mere chemical estimation of its constituent elements becomes of subordinate importance only.

Finally, then, it may be concluded that hard wheats enjoy a comparative immunity from the attacks of the Rust Fungus, and that such wheats can be produced by ordinary cultural operations. There is yet the question whether it will pay to grow wheats of this description, a subject which does not come within the scope of this paper to consider.

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* Analysis of Queensland Wheat and Sugar Soils, with Dr. Völker's Report on their fertility, 1874, p. 17.

† Report to Queensland Investment and Land Mortgage Co. Limited, 28th April, 1887.

CHAPTER XI.

Pests Destructive to Fodder Plants.

LUCERNE.

During the summer months the lucerne growing in the neighbourhood of Toowoomba, and generally about the Darling Downs, is especially subject to the attacks of the caterpillars and grasshoppers which occur then in such hordes (*vid.* "Caterpillars," pp. 223-8, and "Grasshoppers," pp. 217-23).

In addition to these enemies this fodder plant has also several special pests, and notably two species of caterpillars, which injure the young lucerne during July, if not at other seasons of the year also.

Lucerne Caterpillar No. 1 (Fam. *Noctuæ, Agrotis infusa,* Boisd.).

Nature of Injury.—The main stems of the young plants are bitten through close to the ground, and the upper parts are then eaten as they lie upon the surface. Large areas of lucerne may suffer, in patches, from these depredations, and appear as if rendered altogether useless. If, however, the season is a favourable one for the growth of fodder plants, it will be found, since the roots remain intact, that secondary shoots are developed by the lucerne plants, and much of its former vigour is regained. Meanwhile, the caterpillars have disappeared. Under other climatic conditions, however, this fodder plant succumbs to the injury.

Mr. E. M. Hodgson, of Eton Vale, Cambooya, complained, in a letter to the Curator of the Brisbane Museum, that this pest was making great havoc in two fields of lucerne, and that it had attacked two hundred acres of this plant, and sixty acres of wheat and oats in addition. He also stated that his lucerne had been similarly injured in 1886. This lucerne pest in its different phases presents the following characters :—

The Caterpillar.—Cylindrical, tapering from the second body segment towards the head, and also tapering at the other extremity. The tail regularly arched, without any transverse elevation. The labrum is deeply emarginate, and the epistome longtitudinally grooved. The whole surface is covered with fine dark granules, which give a general dark dull hue to the caterpillar, which is brown, mottled with brownish-yellow on the back, whitish-yellow on the sides, and greenish-grey beneath. There is a centro-dorsal, yellowish-brown line, two ill-defined latero-dorsal lines, and two lateral lines between the latero-dorsal one and the spiracles. Below the spiracles there is a continuous ill-defined band, whitish-yellow, intermingled with the underlying colour of the body. The head the last body segment and the first, glossy above; the last mentioned segment dark-brown, with a centro-dorsal light-coloured stripe. A few setigerous spots on body, including two anterior and two posterior on the dorsum of each segment, those on the first and second body segments uniting to form single transverse series. Length, when extended, 2 inches.

The Chrysalis.—Smooth, reddish-brown; the anterior punctured portion of the abdominal segments darker brown; tip of abdomen ending in two straight, slightly diverging thorns. Length, ⅝ inch.

The Moth.—The forewings are elongated, costal margin slightly arched towards the apex; exterior margin slightly oblique, convex in the centre, and slightly hollowed out before and behind, hind margin nearly straight, a little arched towards base; apex obtuse, sub-angular; general colour dark-brown—the scales being light-yellow, light-brown, and dark-brown; sub-marginal band purplish-brown, separated by an irregularly sinuated yellow line from the darker brown marginal band, orbicular and reniform spots cinerous dark-bordered, united by a dark-brown blotch continued slightly beyond them, cilia dark-brown white-tipped. Hindwings short, exterior margin oblique, with pale violet reflections, purplish-brown externally, especially towards apex, brownish-white at base; veins and a slight brown lunule at end of the cell dark-brown; cilia white-tipped, traversed by a dark-brown line. Palpi porrect or slightly ascending, densely clothed with linear scales, first and second joints sub-equal, the latter extending just beyond head; third joint about half length of second, small oblong. Antennæ bipectinated at base, gradually becoming pilose towards the apex. Thorax compactly clothed with reddish-brown scales. Abdomen stout, densely covered with cinereous hairs which become darker posteriorly. Middle and hind legs with stout spurs, the latter with two. Expanse of wings $1\frac{3}{4}$ inch; length of head and body $\frac{13}{16}$ inch.*

Habits.—The caterpillar only feeds at night. During the day it remains hidden in the soil wherein it has buried itself. It progresses with considerable rapidity, moving its head from side to side as it proceeds. When disturbed it curls its body up with head inwards. The moth flies at night.

Remedies.—Considering the habits of the caterpillar, the most efficacious method of dealing with it would, as has been suggested, be that of passing a roller over the affected lucerne after sunset, or when it is known that the pests are out. The caterpillars, having very soft bodies, would thus be destroyed whilst they fed.

CATERPILLAR No. 2 (Fam. *Pyralidæ*).

Nature of Injury.—In the case of this pest the growing shoot of the lucerne plant is gnawn into to its very centre; or the top may be quite severed at from half to an inch or more below the summit.

This caterpillar is by no means so destructive as is the noctuid caterpillar, neither does it occur so numerously. It does not leave the plant on which it has once established itself until it is ready to enter the chrysalis state.

Caterpillar.—A small cylindrical pinkish-hued insect, having the usual glistening setigerous spots characteristic of caterpillars of moths of the family *Pyralidæ*.

Chrysalis and Moth.—Not seen.

NOTE.—This pest was noticed by Mr. E. M. Hodgson, damaging young lucerne at Eton Vale, during July.

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* Dr. T. P. Lucas regards this insect as agreeing with examples of Agrotis infusa, *Boisd.*, contained in his collection. At first appearance it would seem to be closely allied to the common Brisbane insect Agrotis suffusa, which, however, is abundantly different from it. Nevertheless these two species of Agrotis are closely associated in their work of destruction; the caterpillars of the latter being very generally injurious to garden plants and feeding also on weeds.

FODDER PLANTS GENERALLY.

GRASSHOPPERS (*Œdipoda*, sp.).

Toowoomba was visited during December, 1886, by quite a plague of grasshoppers, which did immense damage to the pasture. They, or a portion of them at least, bred in the district, and towards the end of January, and at the commencement of the succeeding month, the unfledged insects might have been seen in some places in myriads, eating the grass down to the roots, and, when disturbed, arising from the ground like a swarm of bees, and moving on just sufficiently to get out of harm's way. On 20th February specimens were procured with the wings quite perfected, although at that time the insects had not arrived at that final stage when these organs of flight are of a firm consistency. It could not be ascertained, at the time of the inquiry, with certainty, whether all the grasshoppers comprised in the December visitation were of one species, nor, if otherwise, whether those which formed the majority of the host then were identical with the insects which were so plentiful in February, 1887. This fact would have been important to learn, seeing that in so-called "locust visitations" in other parts of Australia, it is stated that several distinct species mingle together*, although one is more numerous. In the Adelaide visitation of 1872 it was that swift-flying grasshopper with yellow and black wings (Œdipoda musica) which was the insect which was most numerous.

The Toowoomba grasshopper, however, with which we have to deal, is identical with the one referred to by Mr. T. Bath as occurring in swarms at Learmonth, Victoria, 1873.† Of these Mr. Bath states that they made their appearance on the 17th January; that they travelled at "about the rate of six to eight miles an hour; and being fond of young grass or clover they eat it off quite bare." Further, Mr. Bath adds: "The locusts seem to eat the youngest and sweetest of the grass first, as sheep would do, but after that is gone they will take the stronger, more rank herbage. . . . When most numerous, they were at the rate of about one to the square inch. A dog running over the ground appeared as though running through a swarm of bees, so thickly would the locusts get up around him, and when at a distance he would appear as though in a thick fog. When they had eaten all the grass and other herbage they steered southward, but always left behind them numbers sufficient to eat off the grass, &c., as it grew." *Op. cit.*, p. 71. Dealing with the same insect, these remarks are quite applicable to the pest as it occurred at Toowoomba.

This grasshopper belongs to the Œdipodidæ, a family which includes most of the destructive migratory "locusts." It is a species of Œdipoda, but does not appear to be referrable to any of the insects described under that generic name, or its synonyms, by Audinet Serville, or F. Walker—the only authorities on Acrididæ whose works we are able to consult. The following description may serve to identify it:—

Female.—Vertex extending beyond the eyes, deflexed, terminating in an obtuse point on the frontal costa, margins slightly elevated, central portion very little excavated. A little triangular foveolus, with raised

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* *South Australian Register*, 2nd January, 1872. Quoted in Proc. Ent. Soc., Lond., 1872, p. xi.

† "Report of the Secretary of Agriculture." Melbourne, 1873, pp. 70-73.

margins directed outwards, between the eye and the lateral ocellus. Frontal costa prominent, slightly expanded between the antennæ and more so beyond the ocellus, continued nearly to the clypeus. Frontal ocellus contained in a shallow impression. Whole front of head sparsely punctured—the punctures carrying minute hairs. Pronotum saddle-shaped, constricted at the anterior sulcus, anterior border almost truncate, posterior border rounded behind, little produced and with non-excavated sides, the central keel low and narrow but well defined, scarcely broken by the passage of the transverse incisions, posterior incision in front of the middle, middle division about one-half the length of anterior one, sides of pronotum and of mesonotum rugose. Abdomen extending almost to end of femora of hind limbs with a very obscure central dorsal keel. Elytra and wings passing the abdomen by about one-third of their length. *Colour.*—After immersion in alcohol, yellowish-white with brown spots, the insect having accordingly a reddish appearance. The cheeks are mottled red-brown and white. A broad white stripe from the fore-border of the vertex to the posterior margin of the pronotum, bounded by a broad often ill-defined stripe of dark brown on each side; each of these stripes is traversed by a very distinct fine white line—those of both sides arising from behind the eye, approaching each other on the central keel between the first and second incisions, and then diverging to the posterior border. Sometimes a second broad brown stripe, also ill-defined, extends parallel to this and between it and the lower border of the pronotum. The remaining portions of the thorax have brown blotches here and there. The tegmina or wing-covers are clear, and are ornamented with numerous well-defined greyish-brown spots. Those occupying the inner half the wing-cover are large and tend to form three transverse bars, the two outermost of which are continuous and extend almost from the fore to the hind border. The wings are of a clear milky white, with a dark greyish-brown band occupying the apex and adjoining portion of the hind border. Posterior femora with dark-brown markings on external face, and two more or less well-defined ones crossing the middle third of the inner. Femoro-tibial joint of hind limb also more or less dark brown. Ungues, spines on inner surface of tibia of two first pair of limbs, and on outer surface of hind femora black with white bases. Tarsi, pale-coloured. Length, including head, 1 inch; expanse of wings, $2\frac{1}{4}$ inches; hind femora, $\frac{9}{16}$ inch.

Larvæ.—There is reason to believe that, as in the allied insect Pachytylus migratorius, as Köppen has shown,* this grasshopper undergoes three moults prior to the one immediately preceding that in which the organs of flight become fully developed. We are not, however, yet prepared to state at what period in the growth of the larvæ of our Œdipoda these moults take place. (1) When the insect first hatches from the egg it has no signs of wings or wing-covers, and is almost colourless. (2) When still under $\frac{1}{2}$ inch in length these organs appear as little flaps, without distinct markings, arising just behind the buckler (pronotum), those of one side being widely separated from those on the other. The keel of the buckler is continued, by similar elevations on each dorsal segment, to the hind extremity of the body; and so is the light-coloured central band.

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* Memoir on the Migratory Locust of Southern Russia, in *Horæ Soc. Ent. Ros.* iii., 1867.

(3) At a rather later stage the brown band of the buckler is continued along the sides of the abdomen, and includes a small oblique white line on each abdominal segment; the angular white lines of the occiput and pronotum have also now appeared. (4) The posterior border of the buckler is still shortly rounded; the wings of opposite sides, though as yet rudimentary, meet along their whole length; the wing-covers do not—they are traversed by an oblique white fascia—just beyond their inner third, and outside this, with the exception of the costal margin, they are of a uniform very dark brown. The colours which in earlier stages tended to form bands are now more intensified and pronounced; additional stripes often, too, now appear—*e.g.*, one occupying the frontal costa of the head, and another beneath each eye. The hind tibiæ, too, are now uniform dark brown. (5) The insect now measures ⅝ inch in length; the hind border of the buckler is a little produced, the wings meet wholly and the tegmina in great part, and they extend to between the fourth and fifth abdominal segments. The colours commence to be less pronounced, and the dark brown tibiæ appear annulated with a light-coloured ring. (6) The insect is now ¾ inch in length, the organs of flight extend further back, but of these the wings are still seen between the tegmina; the short oblique white lines on the abdominal segments are merged with the light-coloured central dorsal band; the dark brown of the tegmina commences to be broken up by encroachments of white colour, which arise from their posterior margins. After a few more gradual and nearly analogous changes the larva climbs up into some erect-growing herb or grass-stalk, and having suspended itself by its hind legs there undergoes its fourth moult, in which it develops into a fully fledged insect; but its wings are yet flaccid, and it will be a few days before the Œdipoda will obtain that firm consistency in these organs which is characteristic of the adult. The union of the sexes takes place shortly after this final moult, and the eggs are deposited after an interval of a week or ten days.

Eggs.—This grasshopper lays its long cylindrical eggs measuring 5 mm. (nearly ⅕-inch) in length, and pointed at each extremity, in holes excavated by it in the ground. These holes are circular in form and measure about 4 mm. (⅙-inch) in diameter. They enter perpendicularly into the ground to a depth of from ¼-inch to 2 inches. Numerous holes are found in one spot, and often they are so near together as to be almost contiguous, upwards of twenty having been counted in 2 square inches of ground. Several eggs are placed in one hole, each being laid in an oblique direction to its axis, and enveloped separately in a frothy material which fills it. In places which have been selected by grasshoppers for oviposition the ground appears to have been superficially tilled or scratched up. The holes are made by the grasshoppers themselves by means of four horny plates, with which the abdomen is terminated. These when placed together form a drill-like organ which is thrust into the ground, and when it is in this position the plates are moved asunder by means of powerful muscles, an operation which serves to enlarge the excavation. The segments of the hind body of the female grasshopper, and especially the hinder ones, admit of much extension, owing to the nature of the tissue which unites successive ones; but even then it seems at first difficult to comprehend how one of these insects could bore perpendicularly to a depth of 2 inches. The occurrence of such excavations would seem to be explained by the

fact that the grasshopper, after it has dug to the full extent of its capability, and whilst its abdomen is still within the hole, gathers earth around the mouth of the cavity by the aid of its two pair of fore limbs which it is free to use, and as it drags its abdomen upwards after each act of oviposition so does it go on building, and at the same time it lengthens the distance through which this has to travel. This manipulation of the soil explains, too, the fact that, in places which have been selected by grasshoppers wherein to deposit their eggs, the ground appears to have been superficially tilled or scratched up. The entrances of the holes are generally filled up prior to the eggs being hatched, which takes place after two or three weeks have elapsed. Mr. T. Bath, of Learmonth, Victoria, writing of the grasshoppers as they occurred there, states:—" In February the locusts commence to bore holes in the ground, and lay their eggs. They lay, I have found, from thirty-two to forty-five eggs each. In the choice spots where they deposit their eggs may be seen about 200 holes to the square foot, containing about 8,000 eggs; and many acres are covered thus . . . . The locust bores the hole with its posterior extremity, which is furnished with a horn-like substance, divided into four segments. It has the power of pushing this into the ground and prising off the dirt to make room for the whole abdomen, which is forced into the ground up to the wings, to a depth of about an inch, or inch and a quarter, under the surface. The hole is then nearly filled up with eggs. The locust is unable to extricate itself suddenly from the hole, for if pulled out by the hand often part of the body will remain in the ground. I think the old locust dies shortly after laying her eggs, as numbers of dead ones may be found near the holes."*

Natural Enemies.—This grasshopper is largely destroyed by several insectivorous birds, prominent amongst which are the ibis, the smaller hawks, especially the cinnamon hawk (*Tinnunculus cenchroides*), the magpie lark, *Grallina picata*, and the wood swallows; but there are numerous others with like habits, as must have been observed by all who have been in country occupied by grasshoppers, and especially by this species of Œdipoda. The adults also are bodily carried off and destroyed by those large two-winged flies—the Asilidæ—and ichneumons of more than one species deposit their eggs within them. Their chief enemy, however, in this colony, would appear to be a minute hymenopterous insect, which is found, under the following circumstances, destroying the eggs. When these last are examined by dissection, it will be often observed that the greater part in a nest, instead of containing larval grasshoppers, are almost completely occupied by small four-winged flies, one in each, and it will be noticed that these have lived at the expense of these grasshopper eggs. A closely similar insect has been found in the eggs of the large Acridium which in the Herbert River district has proved in previous seasons so partial to the sugar-cane.

Remedies—Destruction of Eggs.—In contending with this and other grasshoppers, much will be gained by destruction of the eggs, or exposing them directly to the influence of the weather and to the attacks of predatory animals. This may be done by harrowing the ground in which their "nests" have been observed to occur. In some countries where labour is cheap and plentiful, these eggs, or perhaps

* "Report of the Secretary for Agriculture." Victoria, Melbourne, 1873, p. 72.

rather the nests, have been collected and destroyed, as has been done in Cyprus, and with much success, as has been shown by Mr. S. Brown, the government engineer of that dependency.*

Destruction of Larvæ or unfledged young.—Perhaps the most successful measure that can be adopted is one which is directed towards the destruction of the insect when it is still young, hops but little, and cannot yet fly. This has been especially shown in the United States of America, where, though numerous other remedies have been availed of in order to combat the pest, it is found that kerosene "is the very best and cheapest (of the available destructive agents) that can be used against the locusts," and its employment also has there been attended with excellent results. Various contrivances are employed there to facilitate its practical application, and the very crudest qualities of oil are made use of. C. V. Riley, the U.S. Entomologist, writes on this subject as follows:—"The main idea embodied in these contrivances is that of a shallow receptacle of any convenient size (varying from about three feet square to about eight or ten by two or three feet), provided with high back and sides, either mounted upon wheels or runners, or carried (by means of suitable handles or supporting rods) by hand. If the 'pan' is larger than, say, 8 feet square, it is provided with transverse partitions, which serve to prevent any slopping of the contents (in case water and oil are used), when the device is subjected to any sudden irregular motion, such as tipping, as in the case of a wheeled pan when it passes over uneven ground. The wheeled pan is pushed like a wheelbarrow; the hand-worked pan is carried by long handles at its ends. On pushing or carrying, as the case may be, these pans, supplied with oil, over the infested fields, and manipulating the shafts or handles so as to elevate or depress the front edge of the pan as may be desired, the locusts are started from their places and spring into the tar or oil, when they are either entangled by the tar and die slowly, or coming in contact with the more active portion of the oil, expire almost immediately."† The State Entomologist then describes the pans which were employed in the States of Kansas and Iowa, and which were found to be "very effectual" in contending with the notorious migratory locust, *Caloptenus spretus*. He quotes from Riley's *Locust Plague in the United States*,‡ as follows:—

"A good and cheap pan is made of ordinary sheet iron, eight feet long, eleven inches wide at the bottom, and turned up a foot high at the back, and an inch high at the front. A runner at each end, extending some distance behind, and a cord attached to each front corner, complete the pan, at a cost of about $1·50.

"We have known from seven to ten bushels of young locusts caught with one such pan in an afternoon. It is easily pulled by two boys, and by running several together in a row, one boy to each outer rope, and one to each contiguous pair, the best work is performed with the least labour. Longer pans, to be drawn by horses, should have transverse partitions, to avoid spilling the liquid; also more runners. The oil may be used alone, so as to just cover the bottom, or on the

* Report on the Locust Campaign of 1884." Parliamentary Paper, London.

† Report U. S. Ent. Com., quoted in Report of the Entomologist—Department of Agriculture, U.S.A., 1883, pp. 175-6.

‡ Chicago, 1877.

surface of water, and the insects strained through a wire ladle. When the insects are very small, one may ecomonise in kerosene by lining the pan with saturated cloth; but this becomes less efficient afterwards, and frames of cloth saturated with oil do not equal the pans. Where oil has been scarce, some persons have substituted concentrated lye; but when used strong enough to kill, its cost is about as much as that of the oil. The oil pans can be used only when the crops to be protected are small. Small pans of oil, attached to an oblique pole or handle, do excellent service in gardens."

A kerosene oil pan to be drawn on runners, and such as "was used, with much success, in Northern Iowa," is thus referred to :—

"Take a common board, from 12 to 16 feet in length, for the foundation or bed-piece. Make a tin trough, 4 inches deep, 6 inches wide, and as long as required. Divide the trough into partitions by means of strips of tin, so that each partition is a foot long, thus avoiding the spilling of oil. Back of this place a strip of tin, 16 inches wide and as long as the trough. The back must be firmly secured by braces running down to the front edge of the board. Under all this place three wooden runners, 3 feet long, and shod with iron for the troughs to ride on. Fill the pan half full of water and then add a small quantity of kerosene—sufficient to cover the water. A horse may be hitched to the machine by fastening a rope to the outside runners. The lightness of the machine will allow its being used on any crops."*

It has been found an excellent plan in the case of a large grasshopper (a variety of Acridium maculosum), which has been very destructive to sugar-cane in the Herbert River District, to dig long trenches, into which the pests are from time to time driven, to be afterwards destroyed by being trampled upon.

Poisoning.—The use of the castor-oil plant is available for this purpose. The fresh leaves should be scattered in the path of the grasshoppers, and they will be found the more efficacious destroyers the fresher they are. A correspondent, "Delta," in the *South Australian Register*, 2nd January, 1872, writes thus on this subject:—"The locusts in flight descended upon these as on everything else of a vegetable nature, and died after the first few bites; more locusts took their places, so that each leaf was nearly covered with dead bodies, others lay all round who had only strength left to crawl a few paces off, so quickly did the poisonous effects of the sap of the leaf act."

In Queensland, and especially in the warmer parts of it, the foliage of the castor oil is itself destroyed by the caterpillar of a moth—Achæa melicerte. Where such an event is to be anticipated, recourse may be had to another plant—viz., the larkspur, which is also very baneful to grasshoppers. Gardens might, to some extent, also be protected by using a border of this plant.

Poultry.—The grasshoppers are usually so numerous that it would take a very large quantity of poultry to make any appreciable effect on the numbers of these pests which, during an incursion, are met with in any one district. Their influence may, however, be more felt in destroying the comparatively few insects which are always left in a district to breed after the main body comprised in the visitation

* C. V. Riley. "The Locust Plague in the United States." Chicago, 1877.

has passed by. Moreover, whilst the birds are dependent on this source for their food, the usual outlay for their subsistence is saved. Turkeys are especially fond of these grasshoppers.

Those who wish for information on locust invasions in other countries, and how they are met, would do well to consult the "Reports of the United States Entomological Commission" for the years 1877 and 1878-9, issued at Washington by the United States Geological Survey, in which upwards of 1,000 large pages of letter-press are devoted to the subject, and mainly deal with one insect —the Rocky Mountain Locust.

The success which may attend persistent efforts in locust destructions, and in countries where their invasions are most formidable, may be gathered from a perusal of the following summary of Mr. S. Brown's official report, relating to Cyprus :—

"Cyprus has long been desolated by locusts, and even the Turkish Government attempted to deliver it from the plague by collecting the eggs, burning the insects in their early stage, or catching them flying. In 1862 and 1863 Mr. R. Mattei began some experiments which resulted in a system of traps and screens which the British Government is now carrying out. He obtained the hearty co-operation of Said Pasha, the Governor of the island, and after a few years of energetic effort, succeeded in nearly eradicating the pest. Indeed, it was officially reported in 1870 that locusts had ceased to exist in Cyprus. In a few years, however, they once more appeared in desolating swarms, and in 1878, when the island was handed over to the British Government, the system of traps was again set in operation. In the autumn of 1879 37½ tons of eggs were collected and destroyed, yet in the spring of 1880 the swarms were larger than ever. In the autumn of that year the take of locust eggs was 236 tons. Nevertheless the insects appeared in 1881 in still vaster numbers. Greater energy was then devoted in the autumnal collection and destruction of eggs, and no less than 1,330 tons were found and destroyed, at a cost of £12,262. Preparations were also made for trapping the insects in the succeeding spring, when they appeared in vaster numbers than before. In 1882 this work began to tell, and in 1883 the destruction of locusts was enormous; the nearest estimate that could be made of the numbers made them not fewer than 195,000,000 of insects. The result of these efforts has been almost to exterminate the plague. Mr. Brown says that in every previous year of his residence in Cyprus he has ridden through dense flights of locusts in May and June, some of them covering an area of several square miles. This year he has seen nothing of the kind ; no swarms have been observed anywhere, and no damage has been done to the crops. He concludes that locusts need no longer be dreaded as formidable enemies, though their rate of increase is so rapid that a single year's neglect might bring them back in all their destructive force. Like every other natural evil, the plague of locusts is to be held in check by unceasing watchfulness."

CATERPILLARS OR ARMY WORMS.*

Leucania, sp.

Caterpillars in vast swarms appeared at Toowoomba and in different parts of the Darling Downs, and other districts of South

* *Vid.* "Journal of Proceedings of the Entomological Society of London," vol. ii., p. lv., London, 1837, for an account of the migratory habits of a Tasmanian caterpillar—the larva of the noctuid moth *Xylophasia Ewingii*, Westw. The moth here alluded to is figured on pl. xx., fig. 1 of the volume cited. Also see "Magazine of Natural History," New Series, for March, 1839, for an account of a singular procession of caterpillars noticed at Adelaide by Mr. Davis ; and, again, "Transactions of the Entomological Society of New South Wales," vol. ii., pp. 40-48, for a description of a visitation in the neighbouring colony, by Mr. A. W. Scott.

Queensland, early in November, 1886. Their occurrence in the fields adjacent to the Condamine River is thus described in the *Queenslander*, 20th Nov., 1886:—"Caterpillars are in millions of millions. Their appearance has been sudden—that is, within the past fortnight; they are denuding the lucerne of its leaves, also the cereals that are still green; they are upon the grasses, upon many of the herbs, and are destroying almost every flower or annual in the gardens." No samples of these caterpillars were brought under our notice, but from descriptions forthcoming they must have been identical with the caterpillars which visited Cleveland, in the southern part of the colony, during March of the same year. These pests are the early condition of a night-flying moth,* a species of Leucania (Fam. *Noctuæ*).

The following is a description of this pest in its different stages:—

The Moth.—This is fawn-coloured. When undisturbed the wings are directed backwards behind and beyond the body so as to make an angle one with the other. Their surfaces are inclined and their outer borders when in this position leave an angle between them. The eyes are brown and large. There is a frontal tuft of brown-black tipped scales between the latter; the antennæ are minutely ciliated. The body is stout tapering towards the tail which is tufted. Thorax is clothed with fawn-coloured hairs, it has a faint yellow dark-edged transverse stripe on the fore part between the anterior wings, and two oblique rows of black points on the hinder portion, meeting at an angle on the middle line. The abdomen is lighter brown. The fore-wings are elongated, their anterior margin is straight, and their external slightly oblique. Each has a dark discal spot containing a white point anterior to which is a light chestnut suffusion; a short oblique sub-apical brown streak; a line on the outer margin, and an exterior transverse one of black points; internal to latter line and between it and the discal spot is an interrupted waved brown stripe often scarcely discernible. Hind wing short, broad, with apex rounded, and external margin undulated; grey, passing into dark cinereous towards outer border (very distinct beneath); anterior border yellowish white; cilia light yellowish-white. Beneath lighter coloured than above; a longitudinal line containing a few distinct black spots on each side of the abdomen; front border and outer portion of fore-wings and fore-border of hind wings with light black speckled scales; a cloud of dark cinereous colour across outer third of fore-wing. Legs light grey with black specs; fore tibiæ with two, hind tibiæ with four spurs. Extreme length when undisturbed, $\frac{4}{5}$ inch; expanse of wings, $1\frac{3}{5}$ inch; length of body, $\frac{3}{10}$ inch.

* At the time of the occurrence of these hordes of caterpillars the Downs were visited also by immense flights of butterflies mostly journeying towards the North, and it was thought that the caterpillars and butterflies were merely different phases of the same insect. These swarms of butterflies were very general over a great part of Queensland, though their course was not usually northward. Amongst the insects taking part in it were Pieris teutonia, *Fabr.*—the butterfly which was far most numerously represented, Tachyris scyllara, *Macl.*, in much less numbers, and still less frequently Eudonia angulipenne. It is needless to remark that the caterpillars of all these are very different in form and habit from those constituting the devastating host. For instance, the commonest of these Pieris teutonia, *Fabr.*, in the caterpillar stage, is covered with spines, and feeds perhaps exclusively on plants belonging to the extensive order Capparidæ—of which the so-called "native pomegranate" is an example.

The Egg.—The egg is small, white, and shining, but after being laid for some time becomes duller and of a darker colour.

The Caterpillar.—The caterpillar is smooth, with a cylindrical body gradually narrowed towards the head, more suddenly towards the tail; the twelfth segment has no transverse keel above. The mandibles are brown bordered with black; the labrum is sinuated anteriorly and whitish; the anterior clypeus is longitudinally wrinkled; the posterior clypeus has a few transverse fine striæ, and is white with a central longitudinal brown mark or brown with a white border; top and sides of the head netted white and brown; prothoracic plate (shield behind the head) dark brown; remainder of body greyish brown (under the lense appearing mottled brown on a white ground); thoracic legs whitish, with brown claws; abdominal prolegs white, each with a transverse broad smoke-coloured band on its outer surface; spiracles black. Two light yellow broad stripes extend on each side of the back from the fore border of the prothoracic plate, and are irregularly edged with black above; midway between them, along the centre of the back, is a third stripe of the same colour, this is usually interrupted and very indistinct. Below the dorso-lateral stripes are two bands on each side extending the whole length of the insect—one is along its inferior border contiguous to the spiracles, the other is below their level. The latter is the more conspicuous, being cream-coloured, with the central area mottled with light red. There are a few slightly raised hair-bearing black points on each segment. These number twelve on a segment in the mid region of the body, the six on each side being disposed as follows: one above the dorso-lateral line, one in it, one above the spiracle, one below it and on its side, and one at the base of an abdominal proleg. Length of caterpillar, 1½ inches.

The Chrysalis.—This is rich dark reddish brown, smooth and shining, measuring, when fully extended, ⅘ inch in length. The three anterior abdominal segments have each on the fore part a row of punctures between the spiracles; the terminal segment ends in two nearly parallel-directed long sharp depressed spines.

Habits.—The moth is a nocturnal flyer, and during the day remains concealed about the roots of grass, amongst rubbish, under stones, or in such like spots. When disturbed it flies off suddenly and rapidly, soon settles down and quickly runs to a fresh hidingplace. It usually selects spots where the herbage is rank in which to deposit its eggs. We have found these on the introduced grass, Bromus unioloides. The eggs are placed between the two sides of the upper leaves of the plant before these are opened out, and are covered by, what is when fresh, a sticky substance secreted by the female insect. They are also laid in other situations both in concealment on the grass and about rubbish. In about a fortnight—probably less when the weather is warm—the young caterpillars hatch out, and commence feeding immediately on the spot where they were born. At first they are protected by being almost concolorous with the vegetation on which they live, the bands and stripes becoming more pronounced as the caterpillar reaches maturity. They feed nearly always at night, except when the weather is overcast or when they occur in swarms. When disturbed they immediately drop from where they were previously feeding, the young by a thread, the older ones without any.

Having fallen they quickly roll themselves up with the head inwards and remain motionless; after a minute or two they bestir themselves and soon crawl away. Should the plant on which they feed be isolated or offer little concealment they spend the day concealed in the nearest hidingplace they can find, as under a stone or piece of wood. The caterpillar lives from two to three weeks, the duration of the moth in this stage being dependent upon the condition of the weather and the supply of food. This is the extent of its life during the summer months, but in the latitude of Brisbane many pass the winter without changing, hibernating under stones, &c. When about to transform into the chrysalis state the caterpillar burrows an inch or two into the ground or crawls beneath a log or stone—where it barely covers itself with earth, and in such a situation undergoes its metamorphosis. In three or four weeks after this the moth emerges from the chrysalis. The number of generations during the summer months has not been observed, but there are probably several. It has been noticed in America that in the case of an allied insect—a species, too, of Leucania—each female moth lays from 500 to 700 eggs. It was noticed that in the Brisbane district, in 1887, the caterpillars, the progeny of those grubs which had hibernated, were feeding early in September, and that the fully grown insects were depositing their eggs from the 25th September onwards.

Caterpillars of these moths may be found in pastures throughout the year, but it is only when the winter has been mild, and has been succeeded by a spring favourable to vegetation, that the pests increase to such a numerical extent as to become noticeable. It is then, too, that they change their habits, and, in quest of the larger supply of food which they then require, migrate; and, in order to get their share of it, feed to a certain extent by day as well as by night.

Remedies.—The remedies available are such as are directed towards (1) Destroying caterpillars which are still hibernating, when there is reason to anticipate their occurrence, as soon as the winter has passed, in unusual numbers; (2) Preventing those which are on the march from getting access to a crop which they have not yet visited. Any remedies adopted with those ends can, as is obvious, be only partial in their efficacy. In the first place, then, firing the pastures in winter will destroy the hibernating caterpillars in great part; with the second object in view the crop can, to a considerable extent, be protected by encircling it with a ditch. Referring to the Army Worm of the United States, Professor C. V. Riley states:—*"The worms may be prevented, as a general thing, from passing from one field to another by judicious ditching. It is important, however, that the ditch should be made so that the side towards the field to be protected be dug under. About every three or four rods a deep hole in the ditch should be made, in which the worms will collect, so that they can be killed by covering them with earth and pressing it down. They may also be destroyed by burning straw over them—the fire not only killing the worms, but rendering the ditch friable and more efficient in preventing their ascent. I have also used coal-oil (kerosene) to good advantage, and the worms have a great antipathy to passing a streak

* "Report of the Entomologist"—Commissioner of Agriculture's Report for 1881. Washington, 1882, p. 96.

of it. Many of my correspondents successfully headed them off by a ploughed furrow 6 or 8 inches deep, and kept friable by dragging brush in it."

Natural Enemies.—The various native birds perform eminent service in keeping down the number of these caterpillars. We may instance the "magpie" as one very partial to the Leucania grub. Insects, however, are their greatest foes. From our own observations we can particularise two of this class which do eminent service. These are first a conspicuous dipterous (or two-winged) insect, and secondly a minute hymenopterous fly. The former is very similar in appearance to *Tachina* (*Stenometopia*) *miliaris*, Walsh, which "lays its eggs, from one to six in number, on the Army Worm of the United States (*Leucania punctata*), fastening them by an insoluble cement on the upper surface of the two or three first rings of the body. The eggs hatch often after the caterpillar has gone under the ground to transform, and in fifteen to nineteen days the flies appear" (*Packard*). The hymenopteron we have only obtained from the chrysalis in an immature condition.

PRODENIA LITTORALIS.

The caterpillars of more than the one species of noctuid moth above mentioned have the habit of travelling in immense hordes, eating everything up that happens to come in their path. While this Report was being finally revised, there appeared at St. Helena, an island in Moreton Bay, caterpillars in such numbers as to consume nearly the whole of the vegetation there. These were those of a moth—*Prodenia littoralis*—of very extensive range of occurrence outside Australia. In habits it is closely related to the preceding insect, *Leucania*, sp. The caterpillar is more voracious at night, generally conceals itself during the day, and when molested rolls itself up. When fully developed it buries itself in the ground, and there assumes the chrysalis state. The moth itself is a quick flier, and on being disturbed darts suddenly off for a short distance, and then alights again. When stationary its wings are directed backwards, so that their anterior borders form the sides of a rather acute angled isosceles triangle. The moth is common about Brisbane, and may be met with in plenty during the months of March, April, and May.

The following descriptions relate to this pest, and the different phases of its metamorphosis :—

The Caterpillar.—The caterpillar is cylindrical, tapering towards the head from the 3rd body segment forwards, is arched downwards at the 11th and 12th segments and has stout anal prolegs. It is dark-coloured; has an indistinct central dorsal light-coloured line; a lateral dorsal line better defined, widening, and with a black elongated spot contiguous, on the upper side on each segment. This line thus occasionally presents the appearance of a series of lengthened yellow spots. A broad yellow band spotted and reticulated with brown extends along the body below the spiracles; the latter are dark-coloured. A few stiff hairs occur on the body, those on head and limbs being the longer. Length, $1\frac{5}{8}$ inch.

The Chrysalis.—The chrysalis is glossy dark-brown and terminates posteriorly in two small spine-like protuberances. Segments 4 to 7 are anteriorly finely punctured. Length from $\frac{5}{8}$ inch to $\frac{11}{16}$ inch.

The Moth.—This has the fore wings mottled with brown and purplish grey, and intersected by lines and bands of brownish white. The hind wings are of a delicate purplish opalescent white. The following technical description will serve to identify it :—

Male.—Prothorax brown, crossed in front by a dark-brown line and behind by a yellowish-brown one ; patagia fawn-coloured, abdomen cinereous ; fore wings elongate, rather narrow, exterior margin oblique, posterior margin recurved, purplish greyish-brown ; along the costa are some short white oblique streaks with black borders, of which the one nearest the apex is longest and reaches the first branch of the sub-costal vein. A white line (the basal line) extends from the base below the cell and curves upwards to the sub-costal vein ; external to this line is a transverse angulated brownish-white line (the inner line) the lower end of which is bent inwards. Between the basal and inner lines the wing is purplish grey. Crossing obliquely inwards from below upwards, between the inner and "outer" lines there is a whitish-brown fascia, and the reniform spot, within the same limits, has a central area of the same colour. The hind part of the wing between these lines from before backwards passes from brown to reddish yellow. Beyond the outer line, and between it and the marginal lines, the wing is again purplish grey (*aliter* "from the apex across the outer discal area is an oblique purplish fascia"); anterior to the first branch of the sub-costal this purplish-grey band is contracted, only occurring external to the above-mentioned sub-apical oblique streaks. A dark-brown spot adjacent to the marginal lines crosses the median veins, which are here alternated with black streaks. Along the outer borders are two whitish lunular marginal lines, and a blackish denticulated outer one. Hind wing purplish opalescent white, apical border and intra-marginal line brownish coloured, the course of the veins similarly marked by the occurrence of the same brown tinge. *Female.*—Fore wings purplish ochreous brown, with less distinct markings than in male. Expanse of wings $1\frac{3}{8}$ inch to $1\frac{5}{8}$ inch.

This insect is not only common in many parts of Australia, but is also reported as occurring in Europe, Africa, Madagascar, Madeira, Asia Minor, Ceylon, Formosa, and Mauritius.

OTHER PESTS.

White Ants or Termites.

The complaints concerning the injuries inflicted on fruit trees by white ants, which so often emanate from the western and northern parts of the colony, do not seem to arise to any extent at Toowoomba. Mr. Hitchcock, of Mount Pleasant, however, drew attention to the fact that all trees except those belonging to the orange family were subjected to the attacks of termites. Wherever there was a weak point —where a surface of dead wood had been occasioned, either through some accidental circumstance or owing to the operation of pruning, the white ants were sure at such place to find their way into the tree.

With respect to the other districts of the colony above-mentioned, we are informed that :—At Georgetown efforts to grow young fruit trees imported from Townsville have been unsuccessful, owing to their being attacked by termites ; that at Normanton white ants, by their

ravages, even defeat the attempts which the local authorities make to grow shade trees; and that at Surat these insects are accounted a great pest of all fruit trees, and are regarded as an obstacle to their being grown there, especially on "black soil" country. In the last-mentioned district it is the habit of the white ants, in commencing their ravages, to avail themselves of the presence of a so-called weak spot in the stem; but they will frequently start at the collar of the tree, or just at the surface of the ground, and thence work upwards. Trees which have been planted out but two years are killed at Surat by the injuries which white ants inflict upon them (J. Macartney, of Plevna Downs).

In other countries the white ant has been reported as doing injury to growing trees. According to Hagen, at Cambridge, Massachusetts, the maple (*Acer rubrum*) is attacked by *Termes flavipes.** And, again, in Brazil the coffee plant (or rather the beans of the coffee plant) is said to have been destroyed by the white ant, *Termes cumulans.*†

It has been contended that in these cases the trees have already, when attacked, departed from their normal healthy condition, or present signs of external injury; and indeed the facts known regarding the general habits of Termites are corroborative of such an opinion. It is probable that the same holds good for Queensland, for it has been observed:—(1) That trees already enfeebled by drought are especially liable to be attacked; and (2) That those which have been locally raised from seed almost always survive in the presence of White Ants, whilst those which have been imported from distant sources and re-planted usually succumb. In the latter case we know that the plants have not only received a decided check in their growth—their vital functions being for a time practically suspended—but that many of their roots in dying offer spots for the commencement of the injury.

At present it is not possible to name the particular species of Termite which is the most destructive to growing trees. In the northern districts it is evidently a very large variety.

Remedies.—With our limited knowledge on this subject it would scarcely be expected that any successful measure for overcoming the attacks of White Ants could be recommended. However, the use of locally raised seedlings, either as stocks or complete trees, seems indicated. Spots which favour the attacks of the pest might also be dressed with some wash which is distasteful to it. The use of borax or alum solution might, we think, prove serviceable for this purpose.

THE FLYING FOX (*Pteropus poliocephalus*).

Several of those growing fruit in the district of Toowoomba suffer considerable loss from the onslaught made on their fruit by so-called "flying foxes," or fruit bats. When the harvest of fruit is at hand, after working hard during the day, they have either to watch through the night to protect their crops, and so make demands on that capacity for work which the labours of the morrow will require, or else suffer their fruit to be carried off. This tax, either on their energies or on the product of their orchards, is so severely felt that, as several fruit growers informed me—in response to my enquiries, rather than the

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* Canadian Entomologist, xvii, pp. 134-6.

† *Cf.* Smith, in *Trans. Ent. Soc. Lond. 3rd Ser.* vol. v., p. 327.

present condition of things should continue, it would better profit them to individually contribute, year by year, a considerable sum of money in order to secure immunity to their orchards from these marauders. Nevertheless they look to the Government to come immediately to their assistance in this, as in all other matters. But in view of the existence of this willingness to assess themselves, as they should do, in order to reap so direct a benefit, it would seem that all that is further required is the combination amongst themselves to secure the means of winning it. They are already nominally combined in both horticultural and agricultural associations, and it is for these bodies to consider whether provision for the periodical visitation of the camps of the flying foxes—which are already known—in order to wage on these animals sudden and indiscriminate slaughter, might not be regarded as coming within their proper functions. It would moreover appear to be highly probable that the excellent fur of the "flying fox" might, if properly prepared, be advantageously introduced into the European and American markets, and so a considerable offset be obtained against the expenditure attendant on these concerted efforts of destruction.

We have been much interested in knowing—(1) Whether there is at present any demand for the fur of the flying fox in American, European, or other markets ; (2) Whether this article has or does ever find its way into the fur trade ; (3) Whether it is likely to supply any want, or take the place of any fur, less easily procurable, already in the market ? These questions were addressed to J. H. Maiden, the able curator of the Technological Museum, Sydney, who submitted them to local furriers and others. The following are two of the replies received by him :—

(1) "We believe flying-fox fur would prove a new article to commerce, and therefore would require special introduction. *Question No.* 1.—No demand in this market. As to other markets, we think the great textile centres of north-west Europe would readily absorb this article, provided that a fairly large and regular supply could be guaranteed ; otherwise it would be useless for manufacturers to go to the trouble of trying to work it up. *Question No.* 2.—As yet, we do not think this article has found its way into the fur trade. *Question No.* 3—Not likely to supersede any fur now in the market. As to supplying any want, it may do so (see reply to Question No. 1). The wants of a market depend upon a choice out of many goods made. Manufacturers, from a large range of various available supplies, are continually adapting their goods, either in price or novelty, &c."—14th October, 1887.

(2) "Replying to yours of the 12th inst., we have made inquires from furriers and exporters of furred skins and find that a market does not exist here or in any other part, *so far as they are aware*, for the fur of the Flying Fox, and we have not seen it quoted in any circulars."—15th October, 1887.

If, however, these considerations do not discover a sufficient inducement for the direct destruction of the Flying Fox, the fruit may in all cases be secured from their attacks by the use of simple netting suspended above the trees. This fact seems to have hitherto escaped the attention of the Toowoomba fruit-growers, albeit just such a net as is required for the purpose is now being manufactured at the Queensland Machine Net Works, at Toowong. This is made of tanned medium-size cotton netting twine, and of 2½-inch mesh. No doubt it could be retailed at 1½d. per square yard.

Flask Worm (Fam. *Anguillulea*).

Although this general pest of cultivated plants was not met with at Toowoomba there is every reason to expect its occurrence there. In the vicinity of Brisbane we have found it on several occasions amongst wayside weeds, in the roots of the night-shade, Solanum nigrum, and in those of Sida rhombifolia, and in the case of cultivated plants affecting the banana and the broad bean. In the latter instance the plants flowered, but were rendered, by the presence of the Anguillula, altogether unfruitful.

Up to the present our investigations have not proceeded further than merely enabling us to corroborate, in the main, Dr. J. Bancroft's conclusions. Dr. Bancroft has reported the occurrence of this pest on the vine, the banana, the roots of most culinary vegetables, and on those of many weeds. He has also drawn attention to the fact that an Anguillula has been found affecting the roots of the coffee in Brazil. (*Vid.* "Introduction," p. 3.)

Note.—This so-called "Flask Worm," of Dr. Bancroft, is a close ally of *Tylenchus sacchari*, the free nematoid worm which Dr. Soltwedei has quite recently shown is the cause of the disease which has so lately been made known as affecting the sugar cane of the Javanese plantations.

APPENDIX No. 1.

THE APPLICATION OF INSECTICIDES.*

Liquid Distributing Apparatus.

Plates 1a to 1c, Figures 1 to 6.

"*Fineness and Force of Spray.*—In dealing with an enemy so thoroughly protected as are many of the bark-lice, liquid insecticides should be applied in as fine a spray as possible, or at least in moderately fine spray, driven with considerable force, in order to increase to the utmost their penetrating power. The aim should also be to reach and thoroughly wet every portion of an infested tree, so that no individual scale insect shall escape the action of the liquid. This result is not attainable by the old method of sending a jet from a distance into the tops of the trees. An ordinary garden syringe is practically useless. There is needed a force-pump and a nozzle giving a finely atomized spray. This nozzle should be attached to a sufficient length of flexible hose to allow it to be introduced into the top of the tree. The orifice of the nozzle should be directed at a right angle to the hose, and not in a line with it. The jet of spray may thus by a turn of the wrist be directed upward or downward, and brought into contact with all parts of the foliage and branches, from beneath as well as from the upper side.

"*The Cyclone Nozzle* (Plate 1a, Fig. 1—[1] profile; [2] plan; [3] section).—A nozzle which answers the above conditions and is easily attached to any force-pump by means of a rubber tube is described in the report of the Entomologist (Report of the Commissioner of Agriculture for 1881-82, p. 162). It consists of a shallow, circular, metal chamber, soldered to a short piece of metal tubing as an inlet. The inlet passage penetrates the wall of the chamber tangentially, admitting the fluid eccentrically, and causing it to rotate rapidly in the chamber. The outlet consists of a very small hole drilled in the exact centre of one face of the chamber. The orifice should not be larger than will admit the shaft of an ordinary pin. Through this outlet the fluid is driven perpendicularly to the plane of rotation in the chamber. Its whirling motion disperses it broadly from the orifice and produces a very fine spray, which may be converted into a cloud of mist by increasing the pressure in the pump. The perforated face of the nozzle chamber is removable for convenience in clearing the orifice when it clogs. The diameter of the chamber inside need not exceed ½ inch and its depth ¼ inch. A nozzle of these dimensions attached to the aquapult pump covers 1½ square yards of surface at a distance of 4 or 5 feet from the orifice. The amount of dispersion depends somewhat upon the thickness of the perforated face of the chamber. The diameter of the cone of spray may be increased by countersinking the exit hole and making its edges thin.

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* This article is a reproduction of a portion of Frazer S. Crawford's "Report on the Fusicladiums, &c." Adelaide, 1886, pp. 59-62. Though relating in the main to the destruction of Scale Insects, its bearing on that of other pests to vegetation also, is too obvious to need insisting on.

The numbers 1a, 1b and 1c, on the first three plates, have been inadvertently omitted. The lettering on the third plate—1c—is applicable to 1a and 1b also.

"Three-eighths-inch gum (indiarubber) tubing is sufficiently large to supply one, or a gang of several nozzles. The tubing must be strengthened with one ply of cloth.

"In use the end of the hose is supported by being fastened to a light rod of wood, which forms a handle, by means of which the nozzle may be applied to all parts of the tree. For full-sized trees a rod long enough to reach nearly to their tops must be used. For this purpose a convenient device may be made by passing the small rubber hose through a hollow bamboo rod of the required length. A three-sixteenth brass tube inserted in a bamboo rod has also been used.

Pl. 1c, Fig. 6.—"Exhibits a complete outfit for treating orange groves with liquid insecticides. This consists of a common pendulum pump inserted in a barrel and mounted upon a cart. The liquid is delivered through two lines of hose, each ending in a cyclone nozzle. The arrangement here shown permits the spraying of two rows of young trees at once, and thus effects a considerable saving in time. In the same plate is shown an aquapult pump fitted with a cyclone nozzle and a single length (12 feet) of $\frac{3}{8}$ inch hose. The pump is inserted in a pail, ready for use as a portable apparatus for one or, preferably, for two men."*

To this description F. S. Crawford adds as follows:—"Having had several of these nozzles made, I recommend the following modifications as advisable, for reasons which either suggested themselves whilst experimenting with them, or for the purpose of cheapening their manufacture. The part (*a*) to consist of a solid brass rod, about $1\frac{3}{4}$ inch long and $\frac{3}{8}$ inch diameter. Through this to be bored a hole, so that the inlet (*k*) is about $\frac{1}{10}$ inch in diameter, so as to be tangential to the inside edge of the chamber when brazed thereon. The diameter of the inside of the chamber should not be more than $\frac{15}{32}$ of an inch, and its depth $\frac{11}{32}$ inch, while its walls should be at least $\frac{1}{8}$ inch thick, so as to allow an indiarubber washer to rest on the top and prevent the screw cap from leaking. The outlet (*s*) to be about $\frac{1}{20}$ inch in diameter, with the outer part bevelled off much more than shown in the figure, so as to enclose nearly an angle of 90 degrees. The screw of cap (*e*) need not be carried down to the bottom, as shown in the engraving; a depth of $\frac{1}{5}$ inch, with an indiarubber washer, is sufficient to keep the top firm and free from leakage.

"For small gardens a single nozzle, attached by some $\frac{3}{8}$ inch gas tubing to a small force-pump, will be all that is necessary for cleaning rose trees and small plants from aphis, or fruit trees from aphis or scale.

"In larger gardens a 'duplex' nozzle, shown in Pl. 1a, Fig. 2, is advisable, in order to save time. This consists of two nozzles attached by a Y-joint to the hose, and kept in their places by means of two bars of brass, in each of which are two half-grooves for the nozzles to fit in, and which are held together by a screw as shown. This allows the nozzles to be set at any angle the user likes.

"For orchards, I would recommend a triplet consisting of three nozzles, two of them arranged as in the duplex, and a third beneath and between, and about an inch in advance, and set at such an angle as the spray from it should form, with the others, a wide cone (*See* Pl. 1a,

* "Report on Insects Affecting the Orange." By Professor Hubbard.

Fig. 3). The triplet I have had made answers admirably, but, being experimental, was much more expensive than if a manufacturer were to make a number from a single pattern. Figure 3 shows the general arrangement, but I will leave it to any enterprising brass-worker to make them as he thinks best.

"Fig. 5, Pl. 1b, gives a representation of the American aquapult pump, taken from Mr. Hubbard's work. My experiments have been made with an 'Aquarius,' which is somewhat different in arrangement, the pump standing outside the bucket, and having a short suction pipe into it. I find, with ordinary care, $\frac{3}{8}$ inch rubber hose sufficiently strong to stand the force-pump, without being strengthened with one ply of cloth as recommended by Mr. Hubbard. The cloth might, however, tend to preserve the hose, although, as its price is but $4\frac{1}{2}$d. per foot, it does not form a very serious item in the total cost. A force-pump can be obtained for about £2. A triplet cyclone nozzle should not cost more than 12s. or 15s., which with the hose would bring the total cost to about £3. (The prices quoted are Adelaide ones.—H. T.) In using this apparatus the orchardist is cautioned to have the solutions for spraying carefully strained through linen, muslin, or cheese cloth, or other similar material, as owing to the very small exit hole of the nozzle it is very easily choked. For the same reason the suction hose of the pump should have its entrance guarded with fine wire gauze."

Powder-distributing Apparatus.

Plate 2, Figures 1-8.

The following descriptions, illustrated by means of Plate 2, Figs. 1-5, relate to devices perfected by the United States Entomological Department, with the assistance of Dr. Barnard.*

Fig. 1 represents a small bellows, *v*, with handles, *hh*, one of these serving as a discharge spout, communicating at *e*, through the powder receptacle, *p*, to its delivery at *s*. The bellows is made mechanically tight without glue or other adhesive, soluble on exposure to wetness, and possesses great power. Taking the discharge from the handle of the bellows renders it of simpler construction, and enables the hand supporting the powder-can and extension pipe to be close to the can, while the body of the bellows tends to balance the weight of the powder, &c., making the tool more easily wielded than if the weight were more distant from the hand. The form of can is found to be preferably that of a double cone or double pyramid. At its top is a can-screw opening, for inserting the powder and enclosing it securely from wetness. The blast spout passes radially against the inside of the basal cone. The internal relations of the blast to the powder will be better explained by observing Fig. 2, which is a sectional view longitudinally through the parts. The tube, *e r*, inside the can, has a slot in its side, or sides, and about midway in its passage is a shut-off device, *j*, where this is set, partially closing the tubular passage; only a part of the blast going through direct, while the rest is crowded out to grind away the powder exposed by the slot passage. The more of the blast thus

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* Report of the Commissioner of Agriculture.—Rep. of the Entomologist, 1883, pp. 136-137, pl. iv.

crowded out, the more of the powder will be fed to, and carried away by, the blast. One, two, or more slots, or rows of holes, of size and shape to suit, may be thus made whereby the blast can act upon the powder in the base of the can.

Other views of the same device, with an extension pipe, having a crooked discharge end, appear in Figs. 4 and 5. The lettering has the foregoing explanation so far as it corresponds; but *j* indicates the upper or movable face of the bellows, *z* a gauze-cover over its incurrent valve, *i* is the long extension pipe, with a crook, and *s* its discharge. The pipe long enables the poison to be freed at a safe distance from the operator, and the crook allows it to be easily applied either in an upward or a horizontal direction into the plant.

Other crooks desirable for some purposes are shown in the extension pipe as seen in Fig. 3. These blowers work with little effort, and do very satisfactory work.

Figs. 6, 7 and 8 relate to G. T. Campbell's patent bellows for distributing "facing powder"—an operation connected with moulding. The apparatus is equally serviceable to the horticulturist for discharging insect powders, and is an improvement on the "sulphuring bellows" usually employed for this purpose. Secured to the top board of the bellows (Fig. 6) is a box for holding the pulverised substance it is desired to distribute. The box is connected with the bellows nose by a flexible tube, as shown in the sectional view Fig. 7. A wire gauze partition is fitted at the inner end of the box nozzle, to prevent choking up of the powder passages by lumps or foreign substances. The box is filled through an opening bordered by a screw neck upon which the cap fits. When the handles are operated to force the air through the nose of the bellows, some of the air will pass into a box through a check valve pressed down lightly by a spring. This valve (Fig. 8) is so constructed as to admit air to the box at two levels, thereby insuring thorough agitation of the powder in the box, and a more effective distribution of it through the tube and into the nose, where it is met by the main air-blast and ejected forcibly from the nozzle, which is preferably provided with a rose head. The passage leading to the box can be closed at any time by a valve on the inner face of the upper board. This valve is operated by an arm on a crank lever pivoted on the board as shown in Fig. 6.*

The apparatus illustrated by Figs. 1 to 5 is especially useful where poisonous substances such as London purple or Paris green are being employed, and which it is desirable should not be liberated too close to the operator. The last-mentioned appliance may be used for sulphuring or distributing wood-ashes.

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* *Vid.* "English Mechanic," March, 1886, p. 5.

APPENDIX No. 2.

List of Native Insectivorous Birds of the Toowoomba District.*

Tinnunculus cenchroides, *Vig. and Horsf.*—Grasshopper or common hawk
Strix delicatula—Owl
Ægotheles novæ-hollandiæ—Owlet night-jar
Podargus strigoides, *Lath.*—More-pork
Eurostopodus albigularis, *Vig. and Horsf.*—White-throated night-jar
Chætura caudacuta, *Lath.*—Swift (spine-tailed)
Hirundo frontalis, *Quoy. and Gam.*—Swallow or house martin
Hydrochelidon nigricans, *Vieill.*—Martin
Lagenoplastes ariel, *Gld.*—Fairy martin
Merops ornatus, *Lath.*—Bee-eater
Eurystomus pacificus, *Lath.*—Dollar-bird
†Dacelo gigas, *Bodd.*—Laughing jackass
Halcyon sanctus, *Vig. and Horsf.*—Kingfisher
Halcyon Macleayi, *Jar. and Selb.*—Bush kingfisher
Alcyone azurea, *Lath.*—Small kingfisher.
Artamus sordidus, *Lath.*—Plain wood-swallow
Artamus personatus, *Gld.*—Masked wood-swallow or bush-martin
Artamus leucogaster, *Valenc.*—White-rumped wood-swallow
‡Artamus superciliosus, *Gld.*—White-eyebrowed wood-swallow or bush-martin
Pardalotus punctatus, *Temm.*—Spotted diamond-bird
Pardalotus ornatus, *Temm.*—Streaked diamond-bird
Pardalotus melanocephalus, *Gld.*—Black-headed diamond-bird
Strepera graculina, *White*—Pied crow-shrike
Gymnorhina tibicen, *Lath.*—Magpie
Cracticus robustus, *Lath.*—Butcher-bird, shrike, or organ-bird
Cracticus torquatus, *Lath.*—Butcher-bird
Grallina picata, *Lath.*—Magpie-lark or pee-wee
Graucalus melanops, *Lath.*—Blue or smoky jay
Graucalus mentalis, *Vig. and Horsf.*—Blue jay
Campephaga humeralis, *Gld.*—White-shouldered campephaga
Campephaga jardinii, *Rüpp.*—Black campaphaga
Pachycephala gutturalis, *Lath.*—Yellow-belly or yellow thickhead
Pachycephala rufiventris, *Lath.*—Red-bellied thickhead
Collyriocincla harmonica, *Lath.*—Thrush (whistling-thrush)
Falcunculus frontatus, *Lath.*—Shrike-tit
Chibia bracteata, *Gld.*—Drongo shrike or fishtail
Rhipidura albiscapa, *Gld.*—Common fly-catcher, bush fly-catcher, or fantail
Sauloprocta motacilloides, *Vig. and Horsf.*—Black fan-tail

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* The co-operation of Messrs. G. Barlow and Kendal Broadbent in the preparation of this list is hereby acknowledged. The former has supplied the locally current trivial names.

† This bird is inserted with some hesitation. The character which it bears as a destroyer of young chickens might, however, justify the omission of its name from this list, were it not for the fact that it is one of the best destroyers of grasshoppers.

‡ This, like the other species of wood-swallow is destructive to bees, but it is one of the worst foes the grasshopper has. On this subject we may quote the following remarks made in 1873, by the Secretary of Agriculture, Victoria:—"Mr. Davey informs me that during 1870-1 and 1871-2, the locusts on the Wimmera were followed by a flock of birds, resembling in form and flight the swallow, but being of nearly twice the size. This bird he describes as being of a slate colour on the back, and a light-dull brick-red on the breast. These birds, he says, were very active in destroying the locusts. Professor McCoy informs me that this bird is scientifically known by the name of 'Artamus superciliosus.'" (The description, however, does not apply to this bird.—H. T.)

Seisura inquieta, *Lath.*—Shepherd's companion, grinder, or wagtail
Miagra plumbea, *Vig. and Horsf.*—Grey fly-catcher
*Micrœca fascinans, *Lath.*—Stumper
Monarcha carinata, *Swain.*—Black-throated fly-catcher
Gerygone albigularis, *Gld.*—Hanging-dick
Gerygone fusca, *Gld.*—Brown gerygone
Erythrodryas rosea, *Gld.*—Rose-breasted robin
Petrœca Goodenovii, *Vig. and Horsf.*—Red-breasted robin
Melanodryas bicolor, *Vig. and Horsf.*—Black or black and white robin
Eopsaltria australis, *Lath.*—Yellow-belly
Eopsaltria capito, *Gld.*—Robin
Eopsaltria magnirostris, *Ram.*—Robin
Psophodes crepitans, *Vig. and Horsf.*—Coachwhip
Malurus cyaneus, *Lath.*—Blue wren
Malurus Lamberti, *Vig. and Horsf.*—Blue wren
Malurus melanocephalus, *Vig. and Horsf.*—Black-headed malurus or red-backed wren
Amytis striatus, *Gld.*—Striated wren
Cisticola magna, *Gld.*—Grass warbler
Sericornis citreogularis, *Gld.*
Sericornis humilis, *Gld.*
Acanthiza pusilla, *Lath.*—Wren
Geobasileus chrysorhœa, *Quoy. and Gam.*
Chthonicola sagittata, *Lath.*
Anthus australis, *Vig. and Horsf.*—Common lark, lark, or skylark
Cinchlorhamphus cantillans, *Gld.*—Black lark
Ptenœdus rufescens, *Vig. and Horsf.*—Red lark
Calamoherpe australis, *Gld.*—Reed warbler
Mirafra Horsfieldii, *Gld.*—Horsfield's lark
†Stictoptera Bichenovii, *Vig. and Horsf.*—Double-barred finch or sparrow
†Œgintha temporalis, *Lath.*—Redhead
†Aidemosyne modesta, *Gld.*—Plain-coloured finch
Pitta strepitans, *Temm.*—Noisy pitta or dragoon-bird
Ptilinorhynchus holo-sericeus, *Kuhl.*—Satin bower-bird
Ailurædus viridis, *Lath.*—Cat bird
Sericulus melinus, *Lath.*—Regent-bird
Mimeta viridis, *Lath.*—Green oriole
Sphecotheres maxillaris, *Lath.*—Fig-bird
Corcorax melanorhamphus, *Vieill.*—Mutton-bird or happy family
Corvus australis, *Gmel.*—Crow
Pomatostomus temporalis, *Vig. and Horsf.*—White-headed happy family
Pomatostomus superciliosus, *Vig. and Horsf.*—Happy family
‡Ptilotis Lewinii, *Swains.*—Lewin's honey-eater
§Anthochæra carunculata, *Lath.*—Gill-bird
Acanthorhynchus tenuirostris, *Lath.*—Spinebill

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* Where bees are kept this bird will be found to be destructive to them; its general insectivorous proclivities are, however, too pronounced to allow of its omission.

† The above finches, occurring in the neighbourhood of Toowoomba, are seed-eating birds, but, as far as observed, restrict their attention to small seed-bearing wild plants. They are also very partial to those small insects which take up their abode in the buds of fruit and other trees.

‡ Although this honey-eater does occasionally perhaps pierce grapes, its usual food is the honey of flowers, pollen, and insects.

§ The Leatherheads (Philemon spp.), although insectivorous birds are omitted on account of the incursions they make on figs and other fruits.

Myzomela sanguinolenta, *Lath.*—Blood-bird
Myzomela obscura, *Gld.*—Obscure honey-eater
Entomyza cyanotis, *Swain.*—Blue-eye
*Melithreptus gularis, *Gld.*—Honey-eater
†Myzantha garrula, *Lath.*—Mina.
Manorhina melanophrys, *Gld.*—Bell or wedgebird
Dicæum hirundinaceum, *Shaw.*—Swallow dicæum
‡Zosterops cærulescens, *Lath.*—Silver-eye
Zosterops Westernensis, *Q. and Gaim.*—Silver-eye
Climacteris scandens, *Temm.*—Woodpecker
Climacteris erythrops, *Gld.*—Red-browed woodpecker
Sitella leucocephala, *Gld.*—Diamond woodpecker
Cacomantis pallida, *Lath.*—Plain-coloured cuckoo
Cacomantis flabelliformis, *Lath.*—Flesh-coloured cuckoo
Chalcites plagosus, *Lath.*—Bronze cuckoo
Scythrops novæ-hollandiæ, *Lath.*—Channel-bill cuckoo, storm bird
Eudynamis cyanocephala, *Lath.*—Flinders cuckoo
Centropus phasianus, *Lath.*—Swamp pheasant
Ædicnemus grallarius, *Lath.*—Curlew
Lobivanellus lobatus, *Lath.*—Plover.

* This honey-eater also occasionally destroys small fruit; notwithstanding, it does not appear that it is regarded in Toowoomba as a nuisance.

† Occasionally a fruit-eating bird.

‡ This is so eminently insectivorous (wherefore it is elsewhere spoken of as the blight-bird) that its occasional weakness for fruit might be overlooked.

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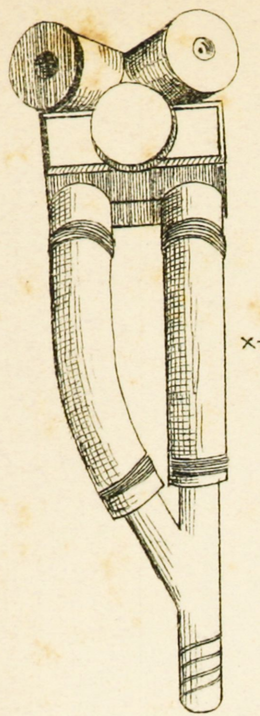

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Fig. 2.

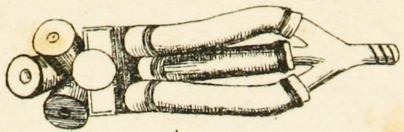

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Fig. 3

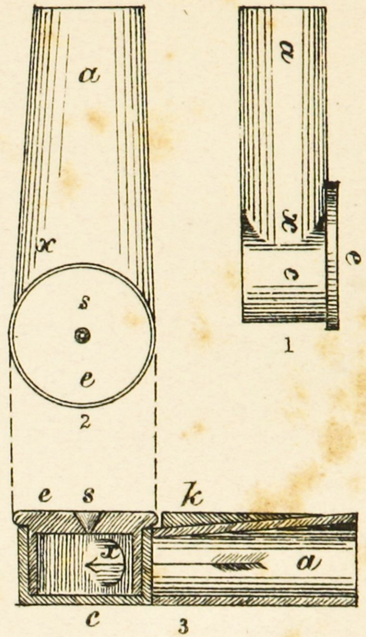

Fig. 1.

Fig. 5

Fig. 4

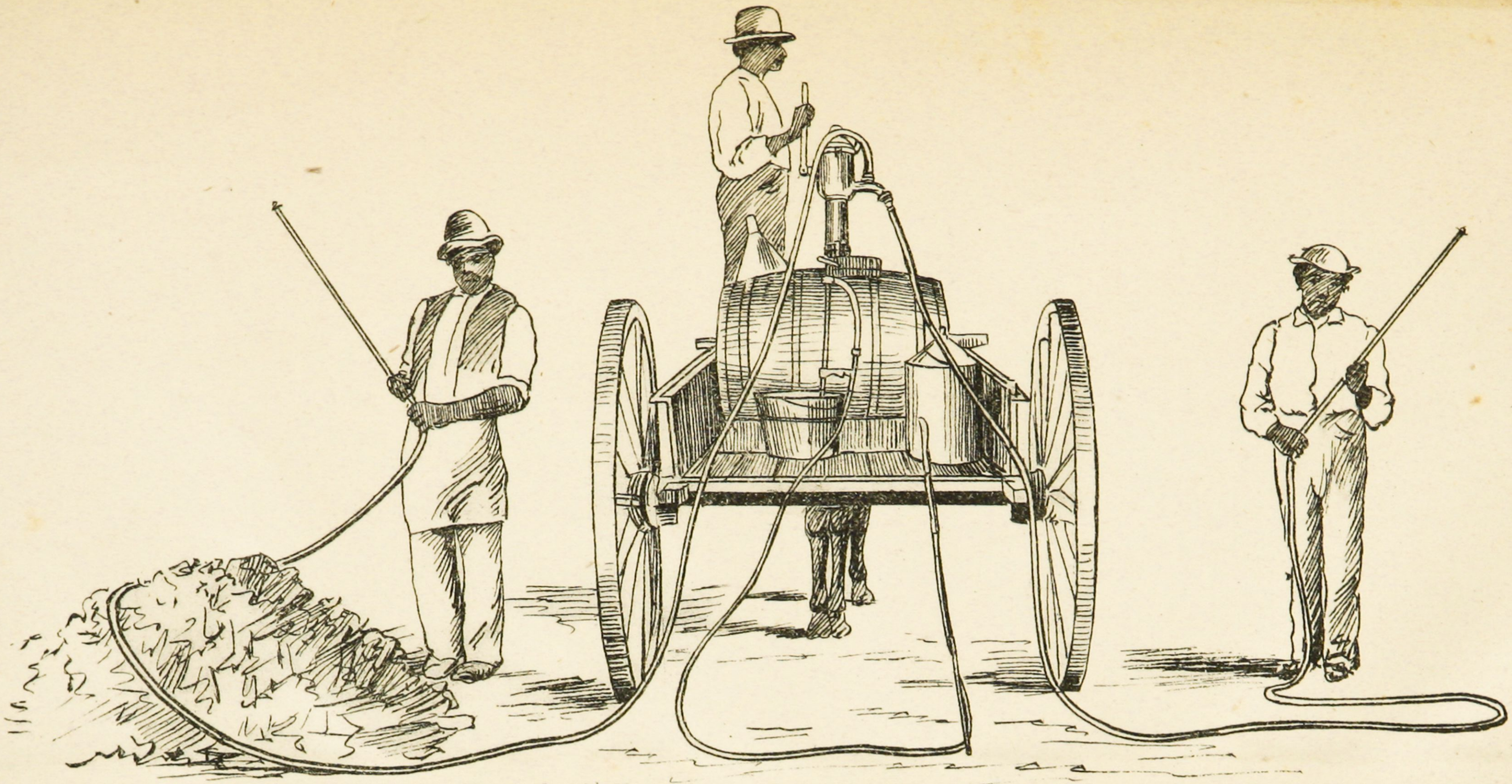

Fig. 6

Spraying Apparatus & Cyclone Nozzle.

(After Hubbard & Crawford.)